CIVIL ENGINEERING

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

PROGRAM • JACKSON, MISS., CONVENTION • FEB. 18-22

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National prestressed pool package for 16′ x 32′ pool—$1300

Pre-Stressed, Pre-cast Concrete Units Solve Labor Costs

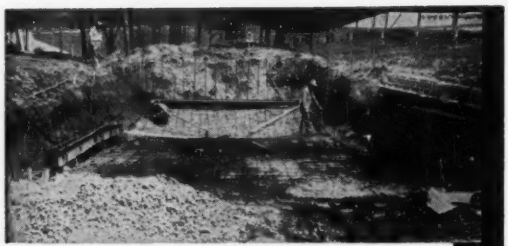
The NATIONAL POOL package includes all fittings special interlocking concrete units, vertical pre-stressing bars, marble-lite material for interior finish and complete filter system. Construction requires no special equipment and can be done with inexperienced local labor. Specially designed pre-cast interlocking concrete wall sections fit into each other and solves cost problem. Pool walls are scientifically pre-stressed to prevent cracking. New method puts swimming pools within reach of all budgets.

PRICES START AT $1,300.00 for 16′ x 32′ PRIVATE POOL COMPLETE WITH FILTER SYSTEM, PUMP, MOTOR AND FITTINGS. PUBLIC POOL PACKAGE PRICE STARTS AT $3464.00 for 20 x 40 POOL. PUBLIC POOL PACKAGES ARE AVAILABLE FOR OLYMPIC SIZE POOLS.

Superior equipment—filter systems—underwater lights—ladders—vacuum cleaners—diving boards—heaters—paint for pool construction. Write for catalogue and price list.

Refer to the May issue of Coronet magazine on NATIONAL POOLS

(Valuable dealer-franchises available to qualified builders, write today for full information)



Excavation for pool showing steel reinforcement for floor and inside pool walls.

Vertical pre-stressing steel rods are ready for interlocking precast concrete units to be placed over them. No heavy construction equipment needed. All work can be done with inexperienced labor.

Walls being pre-stressed by tightening nuts above steel bearing plates, after concrete mixture has been poured inside pre-cast concrete sections. Prevents cracking. No forms needed.

The finished pool has been coated inside with snow white marble-lite. Tile border and coping around top.
NATIONAL
pool equipment co.
Lee Highway
Florence, Alabama
Atwater 2-1620

Combined MILITARY-CIVIC CENTER Adds Permanent Health Insurance

During World War II, the Air Force built a flight base near the quiet little Georgia town of Warner Robins. Almost overnight, it became a bustling city . . . and it has continued to expand ever since. By 1950, its population had reached nearly 8,000. Today, it is estimated at 17,000, and Warner Robins is also the civic center for another 16,000 living on the adjacent military reservation. The city has settled down to steady, long-term growth.

Warner Robins is providing "health insurance" for its future with *permanent* Vitrified Clay Pipe. More than 96,000 additional feet of Clay Pipe in diameters up to 30 inches was recently installed, together with a treatment plant that can be expanded to serve a community of 30,000. Warner Robins, following the lead of many growing cities, is set for the future—with the *only* sewer pipe that *never wears out.*

Mayor: W. T. Giles.
City Engineer: C. M. Franklin.
Architects and Engineers: Vinson & Company.
Chief Engineer: R. M. Breen.
Resident Engineer: W. R. Peck.
Contractor and General Supt.: Howard T. Barry.

The Public *KNOWS* Clay Pipe Is Best

Vitrified CLAY PIPE (CLAY PIPE NEVER WEARS OUT!)

NATIONAL CLAY PIPE MANUFACTURERS, INC.
1820 N. Street, N.W., Washington 6, D.C.
206 Connally Bldg., Atlanta 3, Ga. • 100 N. LaSalle St., Rm. 2100, Chicago 2, Ill. • 703 Ninth & Hill Bldg., Los Angeles 15, Calif
311 High Long Bldg., 5 E. Long St., Columbus 15, Ohio

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- **SELF-CLEANING** – creates greater safety, economy of maintenance, no sweeping or washing required.

See our Catalog in Sweets

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TITLE .....

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All/Weld, Pressure Locked, and Riveted Floor
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BORDEN METAL PRODUCTS CO.

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SOUTHERN PLANT—LEEDS, ALA. — MAIN PLANT—UNION, N. J.

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CIVIL ENGINEERING

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VOL. 27 • NO. 1

THE MAGAZINE OF ENGINEERED CONSTRUCTION

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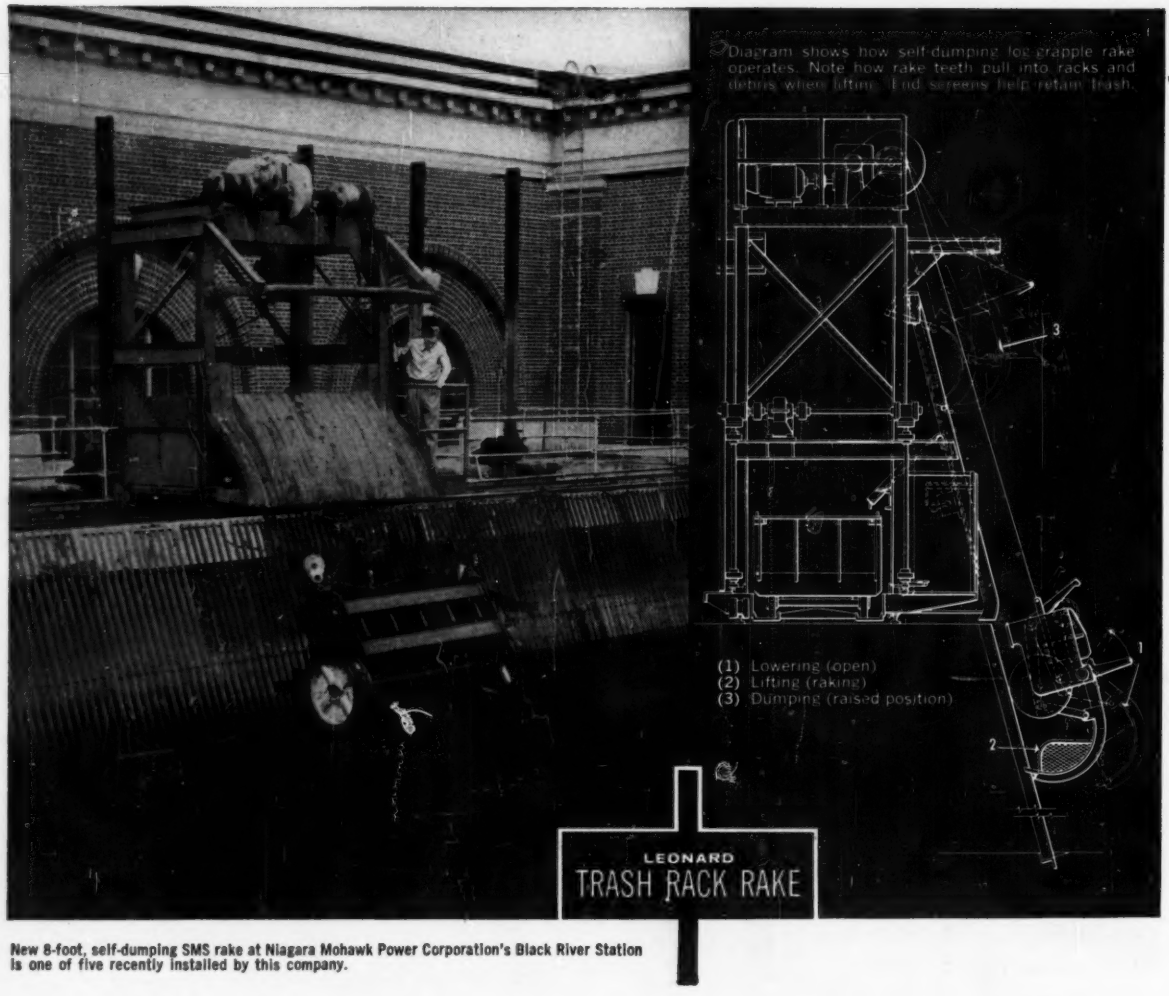
Diagram shows how self-dumping log grapple rake operates. Note how rake teeth pull into racks and debris when lifting. End screens help retain trash.
(1) Lowering (open)
(2) Lifting (raking)
(3) Dumping (raised position)
1
2
3
LEONARD
TRASH RACK RAKE

New 8-foot, self-dumping SMS rake at Niagara Mohawk Power Corporation's Black River Station is one of five recently installed by this company.

Two New Self-Dumping SMS Trash Rake Designs CUT CLEANING TIME AND LABOR

Now SMS offers you two improved Leonard trash rack rakes, both regular and log-grapple types. These self-dumping rake designs make operation easier and quicker, permit you to clean a greater area faster. Both new rake types are now available as additions to the SMS line of standard rake designs.

SMS Leonard rakes operate directly on trash rack bars . . . ride down over stubborn obstructions and work them loose. Such freedom of movement assures fast, easy cleaning. Initial costs are low because the width of SMS rakes can be kept to the minimum required for handling for trash and the expense of guides attached to racks, or embedded in piers is eliminated. These rakes are of simple and rugged construction, designed for outdoor service and require minimum maintenance.

To get full information on Leonard trash rakes, or on other SMS accessories and hydraulic turbines, write to S. Morgan Smith Co., York, Penna. For Leonard rakes, request Bulletin 158.

SMS

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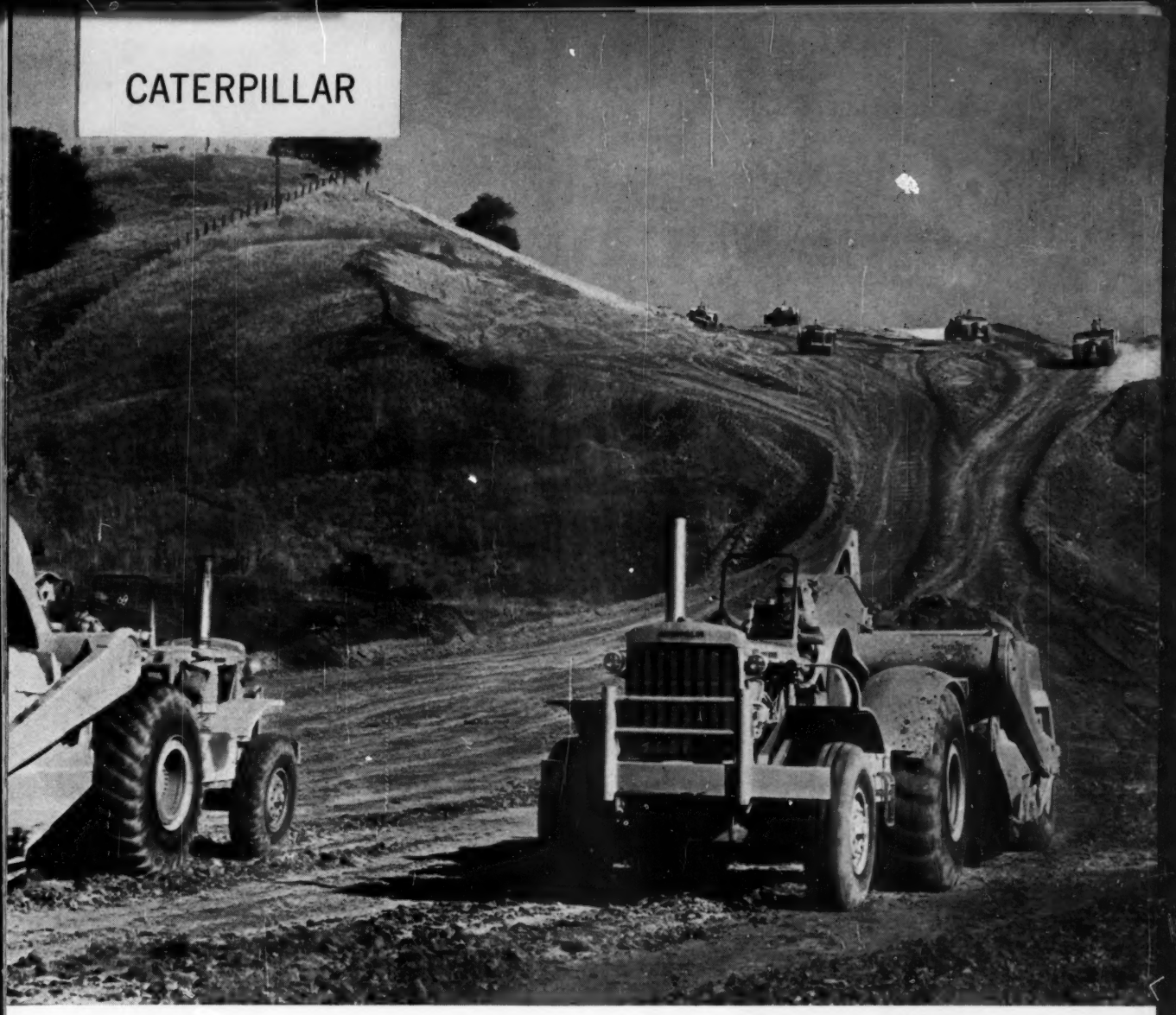


THE ROAD AHEAD

America's new highway program is a 50-billion-dollar challenge to the nation's road builders. Success of the greatest building project ever conceived by man rests with them alone

America has handed the new Federal-aid highway building program to the nation's road builders with complete confidence.

In the next 13 years, the U.S.A. will spend 50 billion dollars building Federal-aid roads alone. From the program will rise a magnificent 41,000-mile system of Interstate Freeways. It totals up to the greatest building project in history.

Only this nation could have the vision for such a program. For only America has the need for it . . . and the resources to see it through to completion. And only America—unawed by bigness—could start such a program without a doubt of its success . . . a magnificent tribute to the nation's road builders.

But make no mistake about it. This is a 50-billion-dollar challenge. It will take co-ordination, co-operation, and the combined experience of the nation's contractors, engineers, Federal and State road officials, bankers, material producers and equipment manufacturers. They start with the nation's confidence. Will they be able to hold it on the long road ahead? The next two pages will give you a clue.

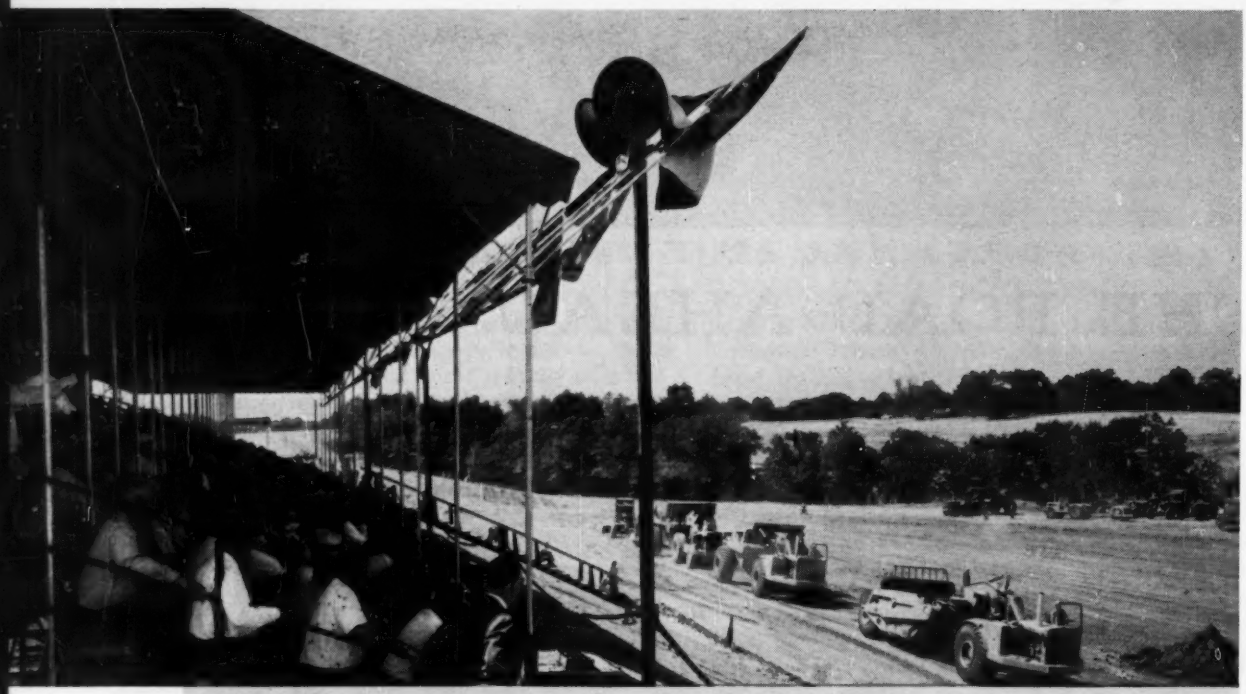
CONTINUED

ROAD BUILDERS RISE TO THE CHALLENGE BY WORKING TOGETHER AS NEVER BEFORE

The key to America's fabulous road-building program is co-operation. The men who must make it work are a diversified group—bankers, engineers, contractors, government officials, materials producers, equipment manufacturers. But they are united today by *one goal* and are setting an example of industry co-operation rarely equaled. Here are some examples of how an equipment manufacturer is co-ordinating its activities with all other groups.

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

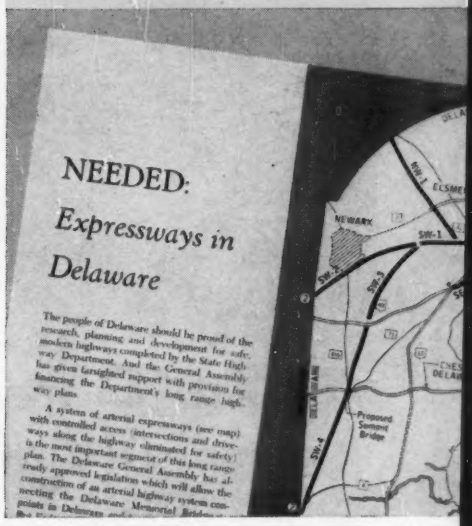
*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.



BANKERS AND EQUIPMENT MANUFACTURERS. Some 180 bankers from every sector of the U.S.A. view the latest earthmoving equipment at the world-famous Caterpillar proving ground in Peoria. A two-day program gives them a close-up of new and improved CAT* equipment—like the giant D9 and the new DW21 with its high-capacity LOWBOWL Scraper—which they finance for contractors. A show like this bolsters confidence—makes credit easier.

CONTRACTORS, GOVERNMENT OFFICIALS, MATERIALS PRODUCERS AND EQUIPMENT MANUFACTURERS. The 1957 Road Show in Chicago this month will demonstrate to contractors, government officials and materials producers that the equipment is ready for the job ahead. Caterpillar's exhibit will feature the new road program in detail and will spotlight the machines on which contractors will depend to accomplish the job.

STATE OFFICIALS AND EQUIPMENT MANUFACTURERS. This Caterpillar leaflet helped road officials in Delaware get important limited access legislation approved. Caterpillar first featured Delaware in a national advertisement, then local Caterpillar Dealers sent reprints like this to legislators and other interested persons in the state explaining the need for limited access legislation. Bill passed soon after.


NEEDED:

Expressways in Delaware

The people of Delaware should be proud of the research, planning and development for safe, modern highways completed by the State Highway Department. And the General Assembly has given farsighted support with provisions for financing the Department's long range highway plans.

A system of arterial expressways (see map) with controlled access (intersections and driveways along the highway eliminated for safety) is the most important segment of this long range plan. The Delaware General Assembly has already approved legislation which will allow the construction of an arterial highway system connecting the Delaware Memorial Bridge

ENGINEERS AND EQUIPMENT MANUFACTURERS. Exhaustive on-the-job tests are made on newly designed equipment to help engineers figure capacity, speed of production. Engineers base their estimates and contracts on the known production capabilities of machines—they depend on those machines to perform with minimum down time. Here the Caterpillar DW21 Tractor with No. 470 LOWBOWL Scraper helps meet the engineers' challenge on the Florida Turnpike.

*In the State of Washington heavy rainfall maintains a very high water table yet the Stang wellpoint installation and supervision kept a 6½-foot x 9-foot nearly vertical walled trench completely dry.

FROM PUYALLUP* TO PAKISTAN...

STANG KEEPS WET JOBS DRY!

Water is where you find it... but, in the construction business, all too often you find water where you don't want it. That's when the Stang dewatering services and equipment can help you—whether your water problem is in Puyallup, Pakistan, or on your own job.

Whatever your water handling job calls for—*call Stang*. Nationwide depots and an experienced foreign service are on constant standby to put your job on a sound, dry footing.

Don't risk delay on your job; choose the right method the first time—call in our Representative. He will supply you with a thorough and accurate analysis of your problem and the Stang recommendation for a speedy, economical solution.

Write for bulletin 100C.

This 150-foot by 400-foot drydock in Karachi, Pakistan, being built for the Pakistan Industrial Development Corp. (Swissboring Overseas Corp., Ltd., Contractor) called for an excavation 40 feet deep with a 32-foot water table—only 50 feet from the water's edge! Dewatering of the job was quickly and efficiently accomplished by a specially engineered installation of Stang wellpoints, supervised by a Stang field engineer. Just one more example of Stang's outstanding water handling services to contractors the world over.

Putting water in its place

563

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Announcing

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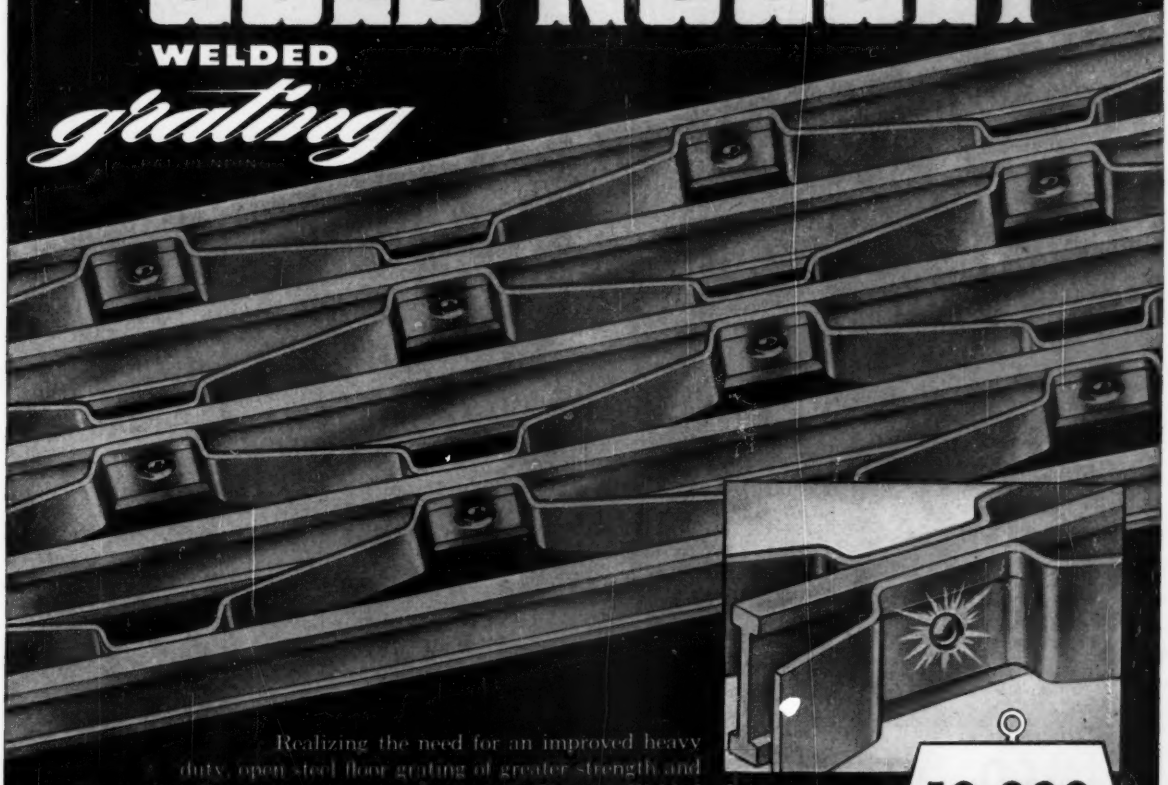
grating



Realizing the need for an improved heavy duty, open steel floor grating of greater strength and economy, The Globe Company presents GOLD NUGGET Welded Grating — the first grating to take advantage of modern engineering design. As a result of this improved design, the GOLD NUGGET primary load bar provides 22% more strength with 14% less weight. The primary load bar is a miniature I-beam with all of the advantages of a true structural member.

GOLD NUGGET Welded Grating is recommended for power houses, loading docks, oil refineries, fire escapes, drain grates, plating rooms, filtration rooms and for all types of heavy duty platforms.

GOLD NUGGET

- $\frac{3}{8}$" projection weld nugget for greater rigidity and strength
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- all bars are load carrying bars including secondary bars
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For the complete details of this revolutionary new grating, write for new catalog today.

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10,000 POUNDS

PROJECTION WELD

Each secondary load bar A (above), as projected welded to the primary load bar B (above), has a shear strength of 5,000 pounds per weld. There are 28 such projection welds to a square foot of grating. This means that GOLD NUGGET Welded Grating can sustain greater shock loads than other gratings.

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Working for a major railway firm in track maintenance operations, an Eimco 105 Tractor-Excavator provides extra-production capacity in loading out a 50-cubic-yard car every eight minutes. The Eimco loads 125 cubic yards more every hour than the machine it replaced.

For this steady job, the 105 is equipped with the high discharge rocker arms and bucket.

The Eimco replaced a 1½ yard shovel that was loading five cars an hour. Before the operator mastered extra-production features of the 105, it was loading six cars an hour. With an experienced operator, it now averages 7½ cars an hour.

Previously, one of two dozers pushing gravel toward the loading edge, came off the 50-foot-high pile to push loaded cars to the switch. The 105 now accomplishes this task and the shovel and one dozer have been released to work elsewhere.

How does the 1½ yard Eimco, with an initial investment that is nearly one-third less, take on extra duty and still increase production?

The answer is in the 105's ability to save time during every loading cycle. With one hand, the operator pushes two, easy-to-reach levers and the Eimco moves in for a load. Powerful crowding actions fills the bucket quickly. He pulls the levers and the 105 reverses to the haulage car while the loaded bucket is elevating in an arc.

When the Eimco is in dumping position, the bucket is in discharge position. There's no lost motion between loading and discharge.

Independent track control permits the 105 to maneuver fast and sharp—another time saver.

And shifting between high and low speeds—forward and reverse—is done under maximum loads at anytime without injury to the transmission. You don't have to stop to shift—or hesitate until the tachometer needle falls below the recommended RPM reading.

The best way to get an idea how the Eimco 105 will increase your production is to watch it perform. You can arrange this today by writing Eimco.

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

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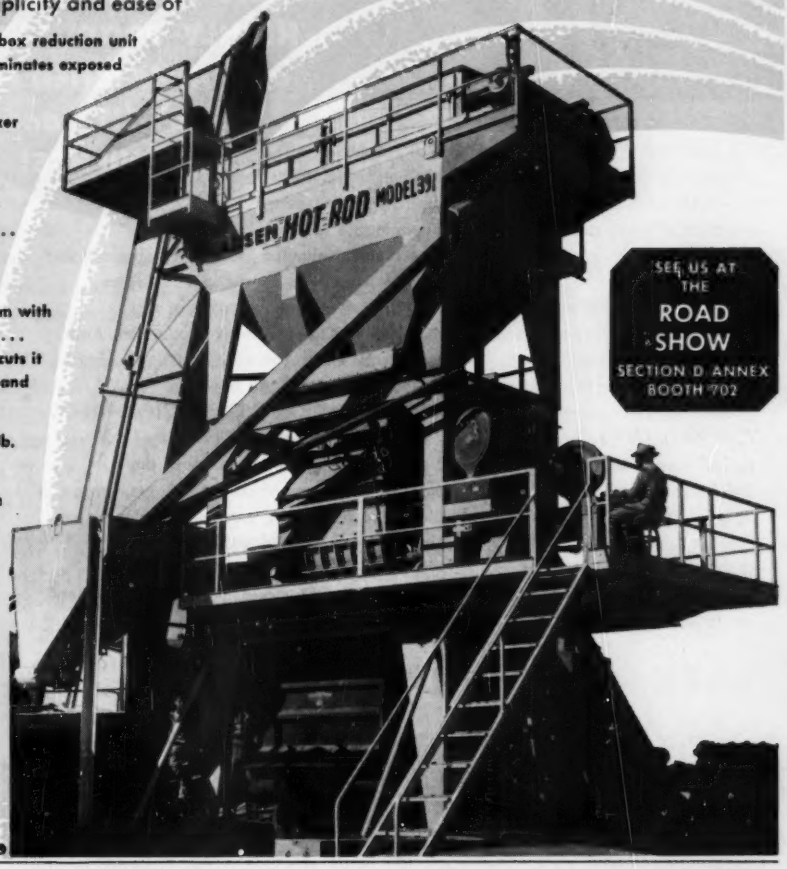
EIMCO

B-227

RIGHT NOW... is the time to "Feature Check" the NEW MADSEN HOT ROD ASPHALT PLANT

As the big road-building program swings into high gear . . . MADSEN offers the industry the sensational new Model 391 HOT ROD Asphalt Plant. You will want to check this plant feature-by-feature because it incorporates many engineering advancements never before offered in any asphalt plant. The HOT ROD has no "excess baggage". It is streamlined in design and very easy to service. It has a minimum of removable parts for transport, a good bin capacity and a choice of mixer sizes. Its simplicity and ease of operation can mean a daily increase in production of a 100 batches over conventional asphalt plant operation. The 5000-lb. MADSEN HOT ROD Plant is capable of producing up to 250 T. P. H. of close specification mixes. No other Asphalt Plant matches the New MADSEN HOT ROD in years-ahead features. A few of these features are shown below . . . check them and then get the complete story from your MADSEN distributor.

- New fully-enclosed (running in oil) gear box reduction unit that goes right to the mixer shafts . . . eliminates exposed mixer timing gears.
- Famous MADSEN Twin-Shaft Pug Mill Mixer (Patented) with externally removable sectional liners, improved mixing action and faster discharge.
- Simplest, cleanest design in the industry . . . with a minimum of removable parts for easy transport and fast set-up.
- MADSEN Asphalt Pressure Injection System with new rotating distribution bar (Patented) . . . injects the asphalt into the mill quickly—cuts it off sharply to give you improved mixing and reduced mixing time.
- Available in 3000-lb., 4000-lb. and 5000-lb. batch capacities.
- Operator station on end of plant . . . with swivel-head asphalt and aggregate scales and all controls conveniently located for easy, fatigue-lessening plant operation.
- Fast air operation of bin gates, asphalt pressure injection system and mixer gate.
- Exclusive bin design (Patent Pending) eliminates segregation.
- In-built breathing device.



SEE US AT THE ROAD SHOW SECTION D ANNEX BOOTH 702

MADSEN Equipment that Serves

Ask your Madsen Distributor for Catalog No. 391 or write Madsen Works, Baldwin-Lima-Hamilton Corp., Construction Equipment Division, P.O. Box 38 La Mirada, Calif.

THE MADSEN LINE OF PRODUCTS FOR THE ASPHALT PAVING INDUSTRY INCLUDES

ASPHALT PAVING PLANTS • PUG MILL MIXERS • AGGREGATE DRYERS • DUST COLLECTOR UNITS
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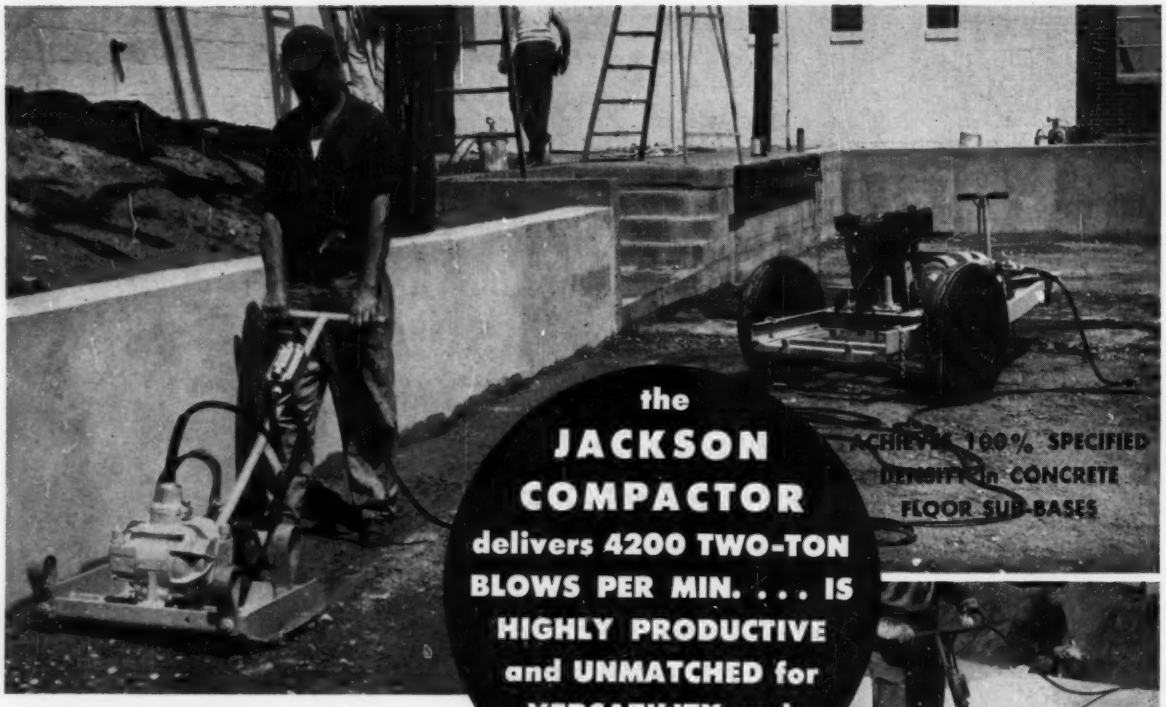


the JACKSON COMPACTOR delivers 4200 TWO-TON BLOWS PER MIN. . . . IS HIGHLY PRODUCTIVE and UNMATCHED for VERSATILITY and CONVENIENCE!

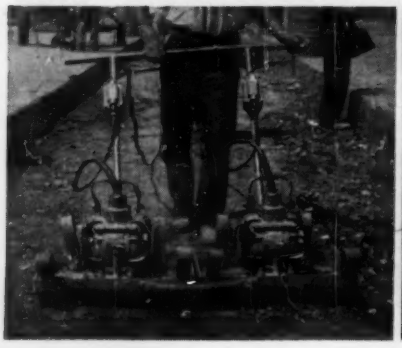
ACHIEVING 100% SPECIFIED DENSITY in CONCRETE FLOOR SUB-BASES

The JACKSON VIBRATORY COMPACTOR, together with a JACKSON auto-trailer-generator unit equipped to quickly pick up and lower the Compactor, is the handiest, most efficient and versatile outfit imaginable for compacting both granular soils and blacktop in an almost unlimited variety of applications. In granular soils 100% specified density is readily achieved in 10" layers at the rate of 1800 sq. ft. per hour. 5" layers of bituminous mixes are also compacted close to maximum density at the same rate of production. And when a twin hookup is used, such as shown below, one man can easily double this production since the machines are self-propelling and need only be guided by the operator. (THE JACKSON IS THE ONLY COMPACTOR WHICH CAN BE USED IN TWIN HOOKUP.) Quickly interchangeable bases of 12" to 26" widths is another feature that adds to the great versatility of the JACKSON COMPACTOR. For consolidating sub-bases of concrete floors, bridge approaches, compacting in trenches, close to abutments, pavement widening sub-bases, patching and widening bituminous pavement and paving blacktop walks and drives this is the greatest money-making outfit you will discover anywhere. See it at your Jackson Distributor. His name and literature gladly sent on request. Write, NOW!

BACKFILL▲▼TRENCHES

JACKSON VIBRATORS INC. LUDINGTON, MICHIGAN

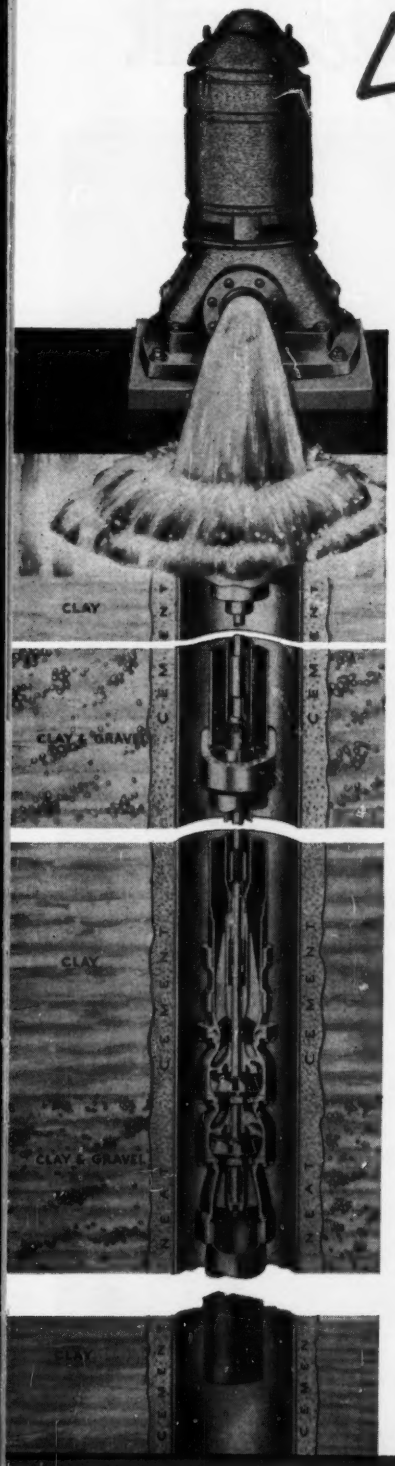
TWIN UNIT DOUBLES PRODUCTION



PAVEMENT PATCHING

PAVING DRIVES and WALKS

Layne knows more about water bearing formations!



On whose say-so? Not on ours—but on the experience of scores of American and foreign firms and municipalities whose very existence and success depend on an adequate supply of water.

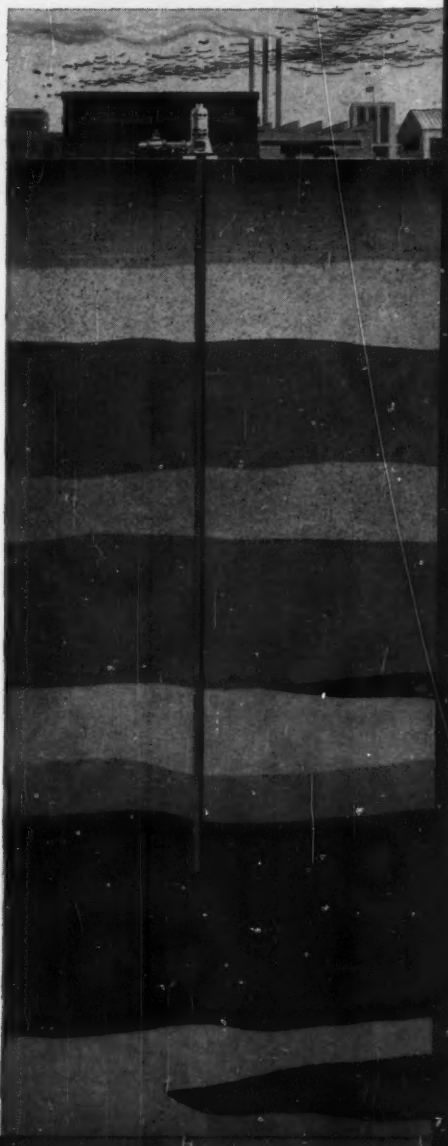
Knowing where the water is — and then tapping the subterranean source is but a part of the vast knowledge the Layne organizations have accumulated in three quarters of a century.

Once the source is determined and the water supply developed, a dependable means for delivering the water must be provided, and that's where the famous Layne pump comes in. For each Layne pump is specifically engineered for the particular job. There is no "stock" Layne pump. Your pump is created for your job —making use of the knowledge of strata, water requirements and usage.

ENGINEERED, DEPENDABLE PERFORMANCE IS WHAT YOU GET WHEN LAYNE DOES THE JOB— COMPLETE FROM WATER LOCATION TO YEAR AFTER YEAR OF TROUBLE-FREE PUMPING.

YOUR NEXT WELL AND PUMP INSTALLATION MAY BE MONTHS OFF. GET TO KNOW THE LAYNE FOLKS IN YOUR AREA. SAVE TIME AND MONEY THROUGH THEIR INTIMATE KNOWLEDGE OF WATER.

Send now for our general services bulletin No. 100.



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75 YEARS OF PROGRESS

WATER WELLS • VERTICAL TURBINE PUMPS • WATER TREATMENT

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General Offices and Factory • Memphis 8, Tennessee

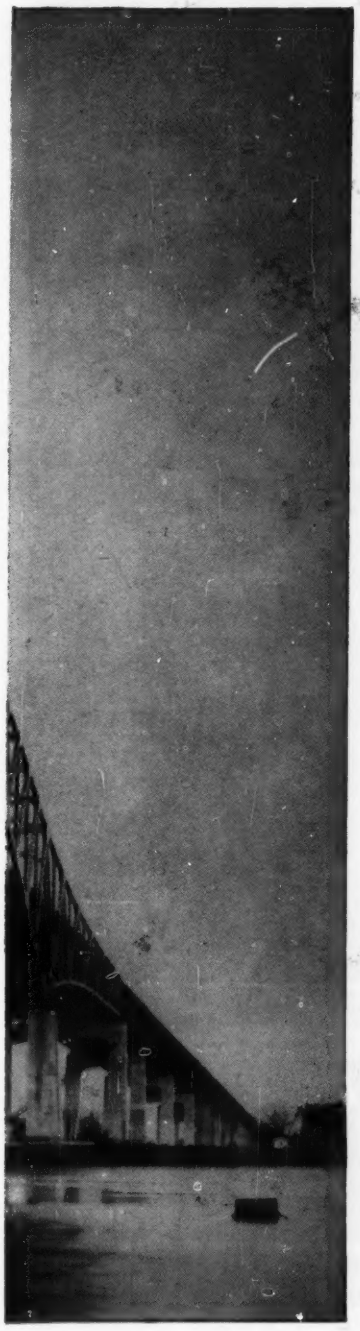
LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

Another important bridge built

USS HIGH STRENGTH STEELS

—the big step forward in bridge construction

better with USS High Strength Steel



11,070 tons of USS MAN-TEN Steel ensure maximum strength and durability

BUILT at a cost of $16,000,000, this new toll bridge over the Delaware River between Edgely, Pa., and Florence, N.J., connects the Pennsylvania and New Jersey Turnpikes and completes the last gap in the east-west vehicular express route from New York City to the Indiana State line. A mile and a quarter long, its 76'6" roadway provides six lanes of traffic.

The graceful superstructure is dominated by a three-span continuous truss bridge, consisting of two 341-ft. side spans, and a 682-ft. center span which rises 270 ft. above the shipping channel to provide a roadway level with a vertical clearance of 135 feet at the center of the main span.

20,144 tons of structural steel were used in the superstructure. 11,070 tons of this are USS MAN-TEN (A242) Steel—the largest tonnage of high strength steel used in a bridge structure to date.

USS MAN-TEN (A242) Steel was used for the main stress-carrying members of all spans, trusses and approaches because of its favorable strength/cost ratio.

If you are looking for superior materials of construction with which you can (1) obtain greater strength with no increase in weight, (2) reduce weight without any sacrifice in strength, (3) insure greater durability, and (4) frequently reduce in-place cost, we will be glad to discuss these advantages of USS High Strength Steels with you.

You will find our 174-page "Design Manual for High Strength Steels" extremely useful in applying USS MAN-TEN and our other famous high strength steels, USS TRI-TEN "E" and USS COR-TEN, to your designs. For free copy, write—on your company letterhead—to United States Steel, Room 5566, 525 William Penn Place, Pittsburgh 30, Pa.

• • •

The Delaware River Turnpike Bridge will be operated jointly by the Pennsylvania Turnpike Commission and the New Jersey Turnpike Authority. It was designed by George S. Richardson, Pittsburgh, Pa.; was fabricated and erected by American Bridge Division of United States Steel.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
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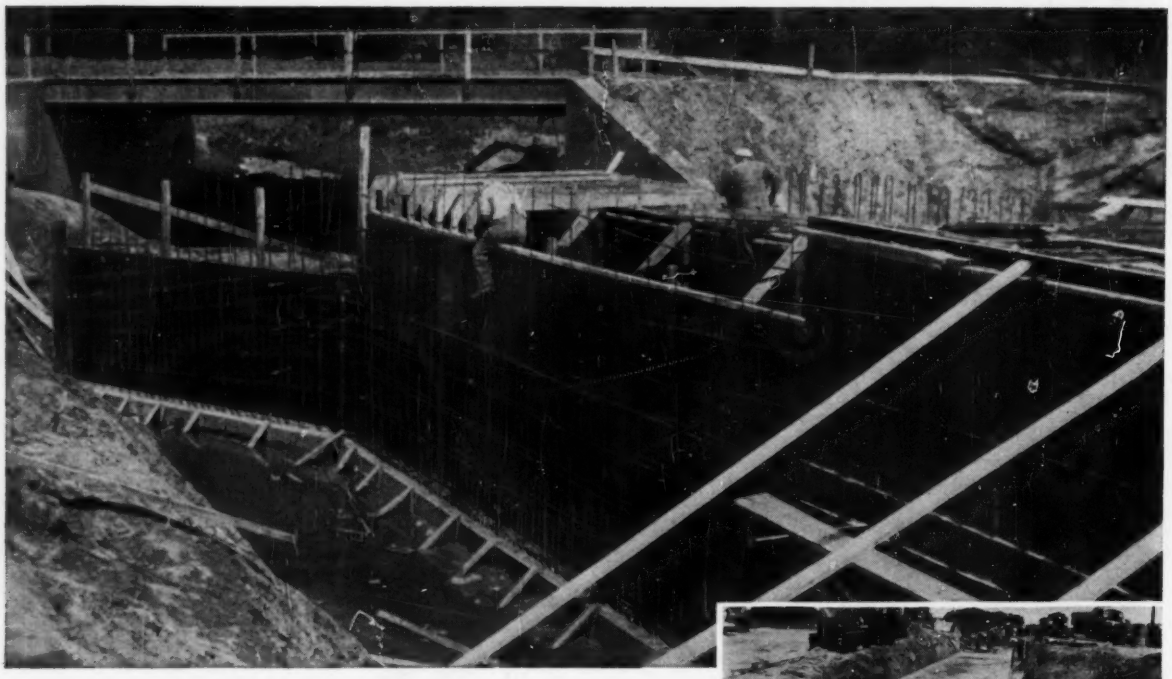
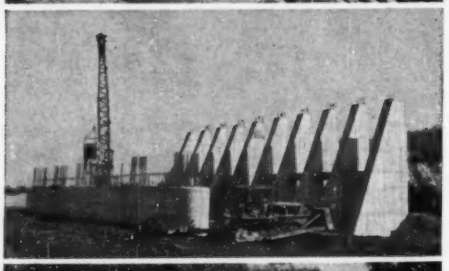
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS HIGH STRENGTH STEELS 1933 1957

UNITED STATES STEEL





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Save LABOR, MATERIAL, TIME!

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Let us prove our point. Send a set of plans for detailed forming specifications, recommendations and cost analysis. There's no obligation, of course.

P1501

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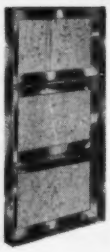
Here Are The Basic Elements:



2. UNI-FORM Tie

3. UNI-FORM Tie Key

1. Steel framed, plywood faced UNI-FORM Panel

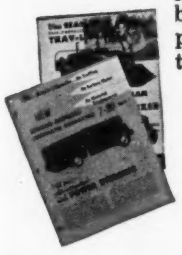
Shoulder to Shoulder—
and on Shoulders, too

SEAMAN-ANDWALL PROVIDES HIGHER DENSITIES AT LOWER BUDGETS

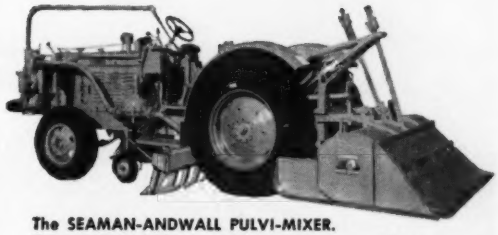
The SEAMAN-ANDWALL Pulvi-Mixer and the Self-Propelled 7-20 Ton Pneumatic Compactor are perfect partners in achieving high density stabilizations. Whether the job be of native soils, soil-cement, bituminous binder or chemical additives the Pulvi-Mixer provides a basic mix that rolls out to the tightest, highest load-bearing, weather resistant base or sub-base. When the Pulvi-Mixer completes its work the mix remains shaped to final grade and crown ready for immediate compaction. No finish blading is needed.

The Pneumatic Compactor . . . Adjustable to any weight between 7 and 20 tons, the Compactor retains the ideal placement and arrangement of coarse and fines which the Pulvi-Mixer established. Because power is applied to the front rolls only presure is "straight down" so there is no displacement of materials, no scuffing and no surface shear.

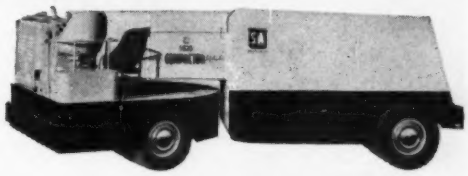
Most maneuverable of all the heavyweights the COMPACTOR turns 180° on a 21 foot road. The operator sits sideways to forward travel, a position in which he has complete visibility of the rolling operation and best control for close-up work. Self-propelled, it is quickly moved from job to job under its own power.



Plan now to make the Pulvi-Mixer and the Compactor your primary, cost-cutting equipment. Send for these two Bulletins completely describing both units. Jot on a postcard "Bulletins TPS and PC" right now and mail it today.



The SEAMAN-ANDWALL PULVI-MIXER.
7 ft. mixing width, gasoline or diesel powered.



The SEAMAN-ANDWALL Self Propelled 7-20 Ton Pneumatic Compactor.

S-A

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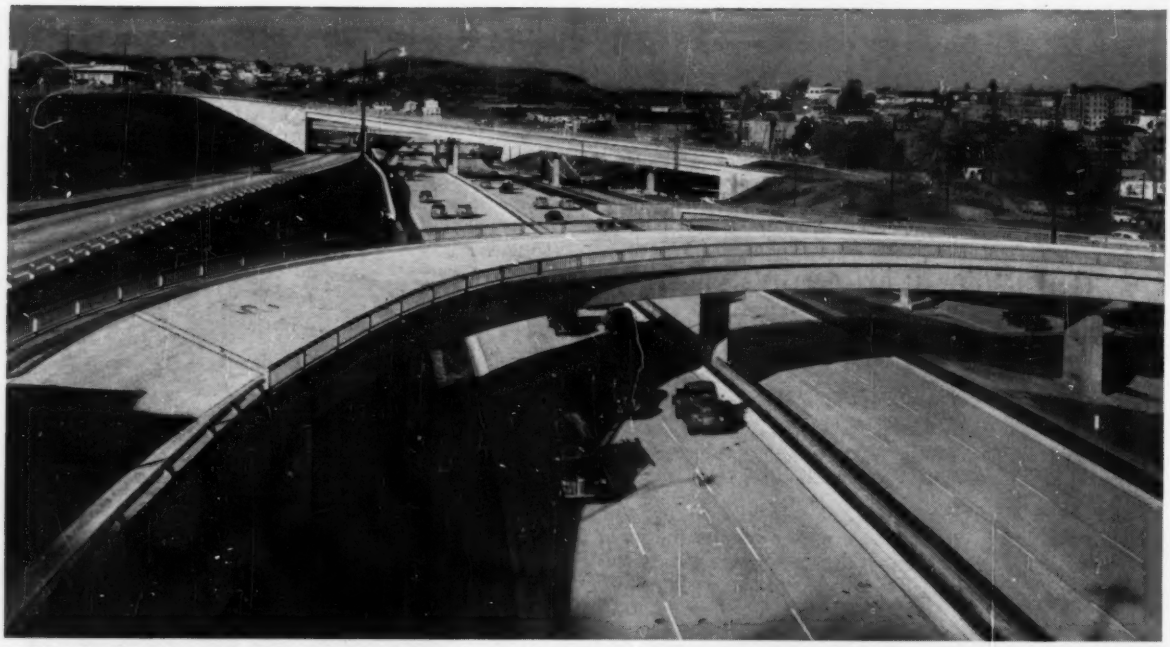
high-speed expressways start quicker ... are completed sooner

From coast to coast, highway engineers are finding that reinforced concrete bridges start quicker because all necessary materials and labor are readily available from local sources. These faster starts, made possible with reinforced concrete, save months of delay.

Furthermore, reinforced concrete is a flexible medium that permits an infinite variety of imaginative and graceful designs. You can design multiple overpass bridges with bold, dramatic lines and soaring curves. Structures built with reinforced concrete are rugged . . . highly resistant to wind, shock, and quake. They are lower in first cost and require less maintenance.

On your next bridge or overpass, design for rugged beauty plus economy . . . design for REINFORCED CONCRETE.



Overcrossing located in downtown Los Angeles carrying local city traffic across the Harbor Freeway, U.S. Highway 6.

Designed by the California Division of Highways

Contractor: Winston Bros., Monrovia, California

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38 South Dearborn Street, Chicago 3, Illinois

For Columbus' new expansion to 120 mgd....

Plant Manager, James H. Blodgett, and Uhlmann Associates, consulting engineers, faced tough problems in doubling the capacity of a previously expanded activated-sludge plant.

To get top plant performance, the complex instrumentation—both old and new—would have to be pulled together. Twenty year old meters would have to be modified, rebuilt, or replaced to work alongside today's improved models, telemetering total influent for the entire expanded plant to *one central control point.*

Here's why Simplex was selected to solve these problems. Simplex redesigned and will rebuild the *old* venturi tube receivers to perform dependably and accurately alongside the newest venturi tubes and meters—specially engineered by Simplex to Columbus' exact requirements. From this integrated system of old and new units spread over a big plant area, Simplex Orthoflow® will *electrically* transmit vital influent data to one central control point—instantly, accurately.

Your Plant. We'll gladly help you in expanding your old plant or planning a new one. Write today outlining your problem. Simplex Valve & Meter Company, Dept. C-1, 7 East Orange Street, Lancaster, Pa.

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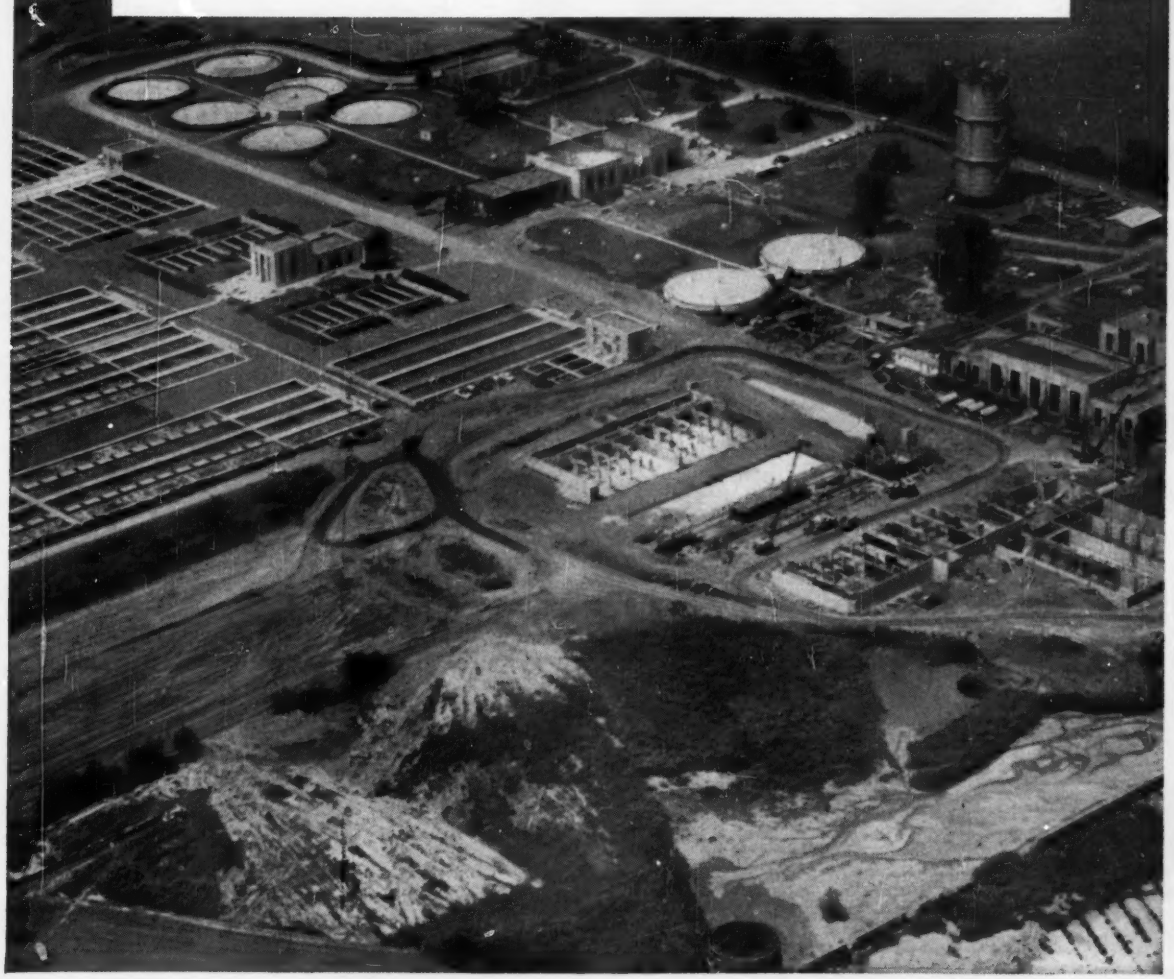
VALVE AND METER COMPANY



If your highway program includes...

THE LAKE PONTCHARTRAIN CAUSEWAY

New Orleans, Louisiana

This imposing structure rests on 4,886 fifty-four inch Raymond Cylinder Piles averaging 88 ft. in length. Completed in August, 1956.

William Watson Bridge, Lake Pontchartrain, La. is supported by 2,795 Raymond Precast Piles. Completed in 1927.

...BRIDGES...BRIDGE APPROACHES...CAUSEWAYS ...INTERCHANGES...OVERPASSES...

Inquire about

RAYMOND CYLINDER PILES

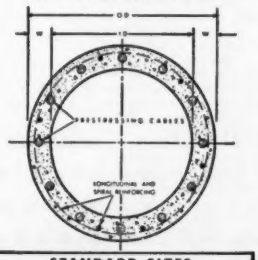
WHY RAYMOND PRESTRESSED CONCRETE CYLINDER PILES ARE SUPERIOR UNDER CERTAIN CONDITIONS

Raymond Cylinder Piles—the latest development in our 60 years' foundation experience—assures greater structural strength, increased load capacity and longer life. These piles are manufactured in a series of sections placed end-to-end, which are joined by post-tensioned cables of high tensile steel wire and grouted to form a homogeneous, impervious support of extraordinary strength. Since Raymond Cylinder Piles are usually driven open end, there is a large area of contact with the soil, which provides greater resistance, thereby enabling higher load capacities. In addition, prestressed concrete insures longer life with extremely low maintenance because it is fireproof and not subject to corrosion or damage by marine life and water.

HOW RAYMOND CYLINDER PILES CAN HELP LOWER CONSTRUCTION COSTS

On large projects, Raymond Cylinder Piles have been a major factor in saving time and money. For example, the new 24 mile Lake Pontchartrain Causeway (shown in the large picture at the left) cost under $8 per square foot to construct. While labor costs have increased 700% and material costs 100%, the cost increase of this bridge has risen only 50% when compared to the cost of the William Watson Bridge, built in 1927 by conventional methods. Utilizing assembly line manufacturing methods and improved installation procedures, the Lake Pontchartrain Causeway—the longest highway bridge in the world—was completed four months ahead of schedule.

CROSS SECTION—RAYMOND PRESTRESSED CONCRETE CYLINDER PILE



STANDARD SIZES			
O.D.	I.D.	W	NUMBER OF PRESTRESSING CABLES
36"	28"	4"	8-10-12-14 or 16
54"	46"	4"	8-10-12-14 or 16

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OUR 60th YEAR

RAYMOND CONCRETE PILE CO.

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You are cordially invited to send for our new Highway Brochure, which gives a detailed resume of how Raymond can help you and the National Highway Program. Just write Department C-1, Raymond Concrete Pile Company, 140 Cedar St., New York

WORLD'S MOST

The Cast Iron Pipe Century Club... Membership in this distinguished Club is restricted to water and gas supply systems still serving their communities through cast iron mains laid a hundred years ago... and more!

The Club's unique Honorary Certificate is earned only through performance. It is a tribute to the service supplied by these companies and to the carrier that enabled them to earn it... world's most dependable pipe... cast iron!

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UNUSUAL CLUB
adds 6 new members

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Dept. of Water and Water Supply
ALBANY, New York
Niagara Mohawk Power Corp. (Gas)
ALEXANDRIA, Virginia
Alexandria Water Company
ALLENTOWN, Pennsylvania
Bureau of Water
*ATLANTA, Georgia
Atlanta Gas Light Company
BALTIMORE, Maryland
Bureau of Water, Dept. of Public Works
BALTIMORE, Maryland
Consolidated Gas Electric Light & Power Co.
BOSTON, Massachusetts
Public Works Dept., Water Division
BOSTON, Massachusetts
Boston Consolidated Gas Co.
BOUND BROOK, New Jersey
Public Service Electric & Gas Co.
BRIDGEPORT, Connecticut
Bridgeport Gas Light Company
BUFFALO, New York
Dept. of Public Works, Div. of Water
CHARLESTON, South Carolina
South Carolina Electric & Gas Co.
CHICAGO, Illinois
Peoples Gas Light & Coke Company
CHICAGO, Illinois
Water Works Department
CINCINNATI, Ohio
Cincinnati Gas & Electric Co.
COLUMBIA, Pennsylvania
Columbia Water Company
DETROIT, Michigan
Board of Water Commissioners
DETROIT, Michigan
Michigan Consolidated Gas Co.
*ELIZABETH, New Jersey
Elizabethtown Consolidated Gas Co.
EVANSVILLE, Indiana
Southern Indiana Gas & Electric Co.
FALL RIVER, Massachusetts
Fall River Gas Works Company
FREDERICK, Maryland
City of Frederick Water Dept.
FREDERICK, Maryland
Frederick Gas Company, Inc.
CITY OF FREDERICKSBURG, Virginia
Gas Department
HALIFAX, Nova Scotia
Public Service Commission, Public Water Supply
HARTFORD, Connecticut
The Hartford Gas Company
HARTFORD, Connecticut
Water Bureau of the Metropolitan District
HUNTSVILLE, Alabama
Municipal Water Works
INDIANAPOLIS, Indiana
Citizens Gas & Coke Utility
*KNOXVILLE, Tennessee
Knoxville Utilities Board (Gas)
LANCASTER, Pennsylvania
Bureau of Water
LOUISVILLE, Kentucky
Louisville Gas & Electric Co.
LYNCHBURG, Virginia
City of Lynchburg Water Dept.
MADISON, Indiana
Natural Gas Service, Inc.
*MEDIA, Pennsylvania
Philadelphia Electric Company Gas Dept.
MINERSVILLE, Pennsylvania
Municipal Authority, Borough of Minersville
MOBILE, Alabama
Mobile Gas Service Corp.
MOBILE, Alabama
Mobile Water Works Company
MONTREAL, Quebec
Quebec Hydro-Electric Commission
MONTREAL, Quebec
Public Works Dept., Water-Works & Sewerage Div.
NASHUA, New Hampshire
Pennichuck Water Works
NASHVILLE, Tennessee
Waterworks Department
NEW BRUNSWICK, New Jersey
Public Service Electric & Gas Co.
NEW HAVEN, Connecticut
New Haven Gas Company
NEW ORLEANS, Louisiana
New Orleans Public Service, Inc. (Gas)
NEWARK, New Jersey
Public Service Electric & Gas Co.
NEW YORK, New York
Dept. of Water, Gas & Electricity
NORRISTOWN, Pennsylvania
Philadelphia Electric Co., Gas Dept.
PAINESVILLE, Ohio
City of Painesville, Gas District Dept.
PEORIA, Illinois
Central Illinois Light Company
PHILADELPHIA, Pennsylvania
Department of Public Works, Bureau of Water
PHILADELPHIA, Pennsylvania
Philadelphia Gas Works Co.
PITTSBURGH, Pennsylvania
Bureau of Water, Department of Public Works
PLYMOUTH, Massachusetts
Plymouth Gas Light Company
POTTSVILLE, Pennsylvania
Pottsville Water Company
PROVIDENCE, Rhode Island
Providence Gas Company
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READING, Pennsylvania
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Department of Public Utilities (Water)
ROCHESTER, New York
Rochester Gas & Electric Corp.
SACRAMENTO, California
Division of Water & Sewers
ST. JOHN, New Brunswick
Water & Sewerage Department
ST. LOUIS, Missouri
Dept. of Public Utilities, Water Div.
SALEM, Massachusetts
North Shore Gas Company
*SAVANNAH, Georgia
South Atlantic Gas Company
SPRINGFIELD, Illinois
Central Illinois Light Company
SYRACUSE, New York
Water Div., Dept. of Engineering
TORONTO, Ontario
The Consumer's Gas Co. of Toronto
TROY, New York
Department of Public Works
UTICA, New York
City of Utica, Board of Water Supply
WHEELING, West Virginia
City of Wheeling Water Department
*WILLIAMSPORT, Pennsylvania
Williamsport Municipal Water Authority
WILMINGTON, Delaware
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WINCHESTER, Virginia
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WINSTON-SALEM, North Carolina
Water Department
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Water Department

New Members in 1956

RESEARCH ASSOCIATION

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MANAGING DIRECTOR

CAST IRON

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NEWS OF ENGINEERS

Walter K. Wilson, Jr., Brigadier General, U. S. Army Corps of Engineers and since May 1956 Assistant Chief of Engineers for Military Construction in Washington, D. C., has been named Deputy Chief of Engineers for Construction. **Maj. Gen. Charles G. Holle,** who has been Deputy Chief of Engineers for Construction since June 1955, has assumed the newly created post of Special Assistant to the Chief of Engineers.

Luna B. Leopold, former hydraulics engineer with the U. S. Geological Survey, Washington, D. C., has been appointed an administrative officer in the reorganization of the Water Resources Division of the Survey. **George E. Ferguson,** formerly chief of the Program Control Branch, has been appointed division hydrologist for the Atlantic Coast area with headquarters at Arlington, Va. **Charles C. McDonald** is chief of the new General Hydrology Branch, which had been added to the Division. He was formerly chief of the Research Section, Technical Coordination Branch, Water Resources Division.

Arthur B. Reeves has retired as chief of the Bureau of Reclamation's Division of Irrigation Operations in the Bureau's engineering offices in Denver, Colo., after 43 years of government service. Mr. Reeves is a recognized authority in the field of irrigation engineering and, as chief of the Division of Irrigation Operations, has supervised the Bureau's irrigation systems in the 17 western states. He has also worked on the design of the Snowy Mountains Hydroelectric Project in Australia and on irrigation projects in Peru.

Arthur B. Reeves

Paul W. Holstein, chief architect for the Regional Office of the Federal Housing Administration, Columbus, Ohio, was recently promoted to the rank of Captain in the Civil Engineer Corps of the U. S. Naval Reserve.

Raymond E. Layton announces a change in name, and relocation of the Raymond E. Layton consulting civil engineering firm, Hayward, Calif. The new firm name is R. E. Layton & Associates, Consulting Engineers, and it is located at 655 West Avenue 135th, San Leandro, Calif.

Norman B. Jones, former senior structural engineer of the California State Division of Architecture at Los Angeles, has taken over new duties as assistant chief structural engineer of the Ralph M. Parsons Company, Engineers and Constructors of Los Angeles, Calif.

James M. Symons has been appointed an instructor in sanitary engineering at Massachusetts Institute of Technology. A graduate of Cornell University, Mr. Symons has been a graduate student in Sanitary Engineering at M.I.T. where he received his master of science degree in 1955 and is a candidate for the doctor of science degree in June 1957.

Samuel S. Steinberg, dean of the University of Maryland College of Engineering since 1936, is resigning as of January 1, to become president of the Technological Institute of Aeronautics at San Jose dos Campos, in the state of Sao Paulo, Brazil. This new government-sponsored civilian university, founded in 1950 and still under construction, will train engineers and technicians at all levels to help develop Brazilian aviation and the Brazilian Air Force.

Clifton E. R. Lawson, formerly with Berger Associates, Inc., Ithaca, N. Y., has joined the Ithaca consulting firm of B. K. Hough. Mr. Lawson will work as a soil engineer on soils and foundation problems related both to structures and transportation facilities.

Roy E. Hunt of Clifton, N. J., has joined the staff of the Esso Research and Engineering Company's construction engineering division in Linden, N. J. Prior to joining Esso Research, Mr. Hunt was an associate soils engineer with Greer Engineering Associates in Montclair, N. J.

George E. Warren, president of Southwestern Portland Cement Co., Los Angeles, was elected chairman of the board of directors of the Portland Cement Association at that organization's annual meeting in Chicago. He has served on the board of directors since 1953 and been a member of the executive committee for the past year.

INTEGRITY COUNTS in PUMPS, Too

This DISTINGUISHED PUMP will win your RESPECT
TYPE OJ
AURORA® Horizontally Split Case, Double Suction, Single Stage Centrifugal Pump
For general water supply for municipalities, industries, office buildings, institutions—also—for handling liquids, chemical solutions, oils etc., in a wide variety of industries. Write for Bulletin 105-BM for further details.
AURORA Always PUMPS

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THE NEW YORK AIR BRAKE COMPANY
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INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

Paul J. Garber, former assistant chief, Military Design Branch, Omaha District, Corps of Engineers, has been transferred to the Western Office of Design and Construction of the National Park Service at San Francisco, Calif. In his new position, Mr. Garber is serving as supervisory engineer. His address is 1318 De Soto Avenue, Burlingame, Calif.

Gilbert V. Levin, for the past five years public health engineer and Civil Defense coordinator for the District of Columbia Department of Public Health, joined the staff of Resources Research, Inc., of Washington, D. C. on December 1. The firm serves private industry, government agencies, local communities and universities in engineering and applied research.

Marble J. Hensley, traffic engineer of Chattanooga, Tenn., and head of an international committee recommending improvements and standardizations in traffic signal design, presented proposed specifications to an international convention on traffic in San Francisco during the fall. The proposals included larger lenses and turn-indicator arrows, brighter lamps, standardized position of red and green lights for benefit of the color-blind driver, and electronic control of lights.

Harvey Banks Kinnison, for the past thirty years New England district engineer of the Geological Survey's Surface Water Branch with offices in Boston, has been named Branch Area Chief for the Western states, with headquarters in Menlo Park, Calif. Succeeding Mr. Kinnison in Boston will be **Charles E. Knox,** who has served for many years as assistant district engineer.

Lawrence D. Daley, J.M. ASCE, receives his stripes and is congratulated by commanding officer, Col. Andrew P. Rollins, M. ASCE, upon being promoted from corporal to sergeant in the Corps of Engineers at the Waterways Experiment Station, Vicksburg, Miss. He is engaged in a study designed to minimize damage and danger from atomic blasts.

George E. Symons, consultant and technical editor of Larchmont, N. Y., has discontinued his private practice to become executive vice-president and editorial director of the Scranton Publishing Co., Inc., New York City and Chicago. In his new position Dr. Symons will supervise all fiscal production and editorial operations of *Water & Sewage Works, Industrial Wastes, Modern Highways* and books published by the organization. He will also supervise market studies and will be co-editor of the Reference and Data Number of *Water Sewage Works*. His headquarters will be in New York.

G. E. Symons

Stephen E. Smith, Colonel, U. S. Army Corps of Engineers, reported to U. S. Army Forces Far East in Korea this month. He has been serving as district engineer for the Corps of Engineers in Baltimore, Md., since September 1954.

Patchen and Zimmerman, Engineers of Augusta and Atlanta, Ga., announce the expansion of the management function of the firm by the addition of six associates: **Clifford D. Williams,** chief engineer, Augusta; **T. W. Seibert,** head civil engineer, Augusta; **Charles C. Biddle,** head sanitary engineer, Augusta; **Ted W. Ellis,** head electrical engineer, Augusta; **Allan W. Gilman,** head structural engineer, Augusta; and **Joseph Leopold,** project manager at Atlanta.

Ray L. Marshall has been named Dallas area sales representative for the Texcrete Structural Products Co., an affiliate of Texas Industries, Inc. Previously Mr. Marshall headed his own construction and engineering firm in Dallas.

Clinton D. Hanover, Jr., will continue his engineering practice under the firm name of Hardesty & Hanover with offices at 101 Park Ave., New York City. **Shortridge Hardesty,** Hon. M. ASCE, partner and consulting engineer in the firm passed away recently (November issue, page 78). Mr. Hanover was recently installed as Director of ASCE.

Oswald Speir retired in October as principal civil engineer for the South Pacific Division of the Corps of Engineers at San Francisco after 22 years of service in the Corps. He is now supervising hydraulic engineer for the California State Department of Water Resources, Division of Water Resources Planning, Project Development Branch, at Sacramento. As of January 1 Mr. Speir attained Life Member status in the Society.

(Continued on page 26)

POCKET COMPUTER

Field parties and job inspectors making frequent on-the-spot high precision computations are aided by new pocket-size computing machine of single-step drum type. The 8-oz. CURTA multiplies an 8-digit number by a 6-digit number and gives an 11-digit answer. Operates like standard office machine; adds, subtracts, multiplies, and divides.

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News of Engineers

(Continued from page 25)

Garvin H. Dyer, director of the Missouri Water Company and manager and chief engineer of the Independence Division of the firm, has been nominated for the office of president of the National Society of Professional Engineers. Among the vice-presidential nominees are **John B. McGaughy,** consulting engineer with Lublin, McGaughy & Associates of Norfolk, Va., Southeastern Region, **W. L. Hindermann,** division engineer with the Asphalt Institute, St. Paul, Minn., North Central Region, and **Clark A. Dunn,** executive director of Engineering Research at Oklahoma Agricultural & Mechanical College, Stillwater, Okla., Southwestern Region.

Carroll F. Newton, Colonel, U. S. Army Corps of Engineers, formerly chief of the Research & Development Division, Office of Chief of Engineers, Washington, D. C., has reported for duty as a student at the Industrial College of the Armed Forces, at Fort Lesley J. McNair, Washington, D. C. Colonel Newton is one of 144 senior Army, Navy, Air Force and Marine Officers and professional civil servants, selected for important policymaking, command and staff assignments within the national security structure. The course is of ten months duration.

Clarence E. Blee is retiring on January 1 as chief engineer of the Tennessee Valley Authority after 13 years in the post and 21 years on the TVA staff. He is planning a trip to Africa immediately

C. E. Blee

G. K. Leonard

after retirement and upon his return to the United States will engage in consulting practice. Mr. Blee will be succeeded by **George K. Leonard,** now chief construction engineer.

James W. Follin, until recently commissioner of the Urban Renewal Administration and former deputy administrator of the Federal Works Agency, announces his resignation from federal service to enter the practice of engineering and to become urban renewal consultant to DeLeuw, Cather & Company Engineers. Mr. Follin will practice from the company's Washington offices at 1308 Eighteenth Street, N. W., Washington, D. C.

Curtis J. Hooper is now an associate in the firm of Wilbur Smith & Associates of New Haven, Conn. He was formerly director of Traffic-Planning-Design in the Connecticut State Highway Department, and more recently was an associate in the firm of Parsons, Brinckerhoff, Hall and Macdonald.

John L. Merriam, former engineering specialist for the Soil Conservation Service in the area office at Riverside, Calif., is now senior irrigation engineer for the Ministry of Agriculture of Saudi Arabia in charge of establishing an Irrigation and Drainage Section in the Division of Water Resources. His address is c/o E. A. Juffali, P.O. Box 297, Jeddah, Saudi Arabia. The project will be under the technical guidance of the Ralph M. Parsons Engineering Co.

Gerald A. Fleet of White Plains, N. Y., has been appointed New York district sales representative by the American Well Works, Aurora, Ill. He will serve the New York district, including the metropolitan area, northern New Jersey, southeastern New York and western Connecticut. Mr. Fleet has been associated with the American Well Works for some time.

(Continued on page 28)

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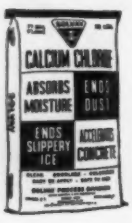

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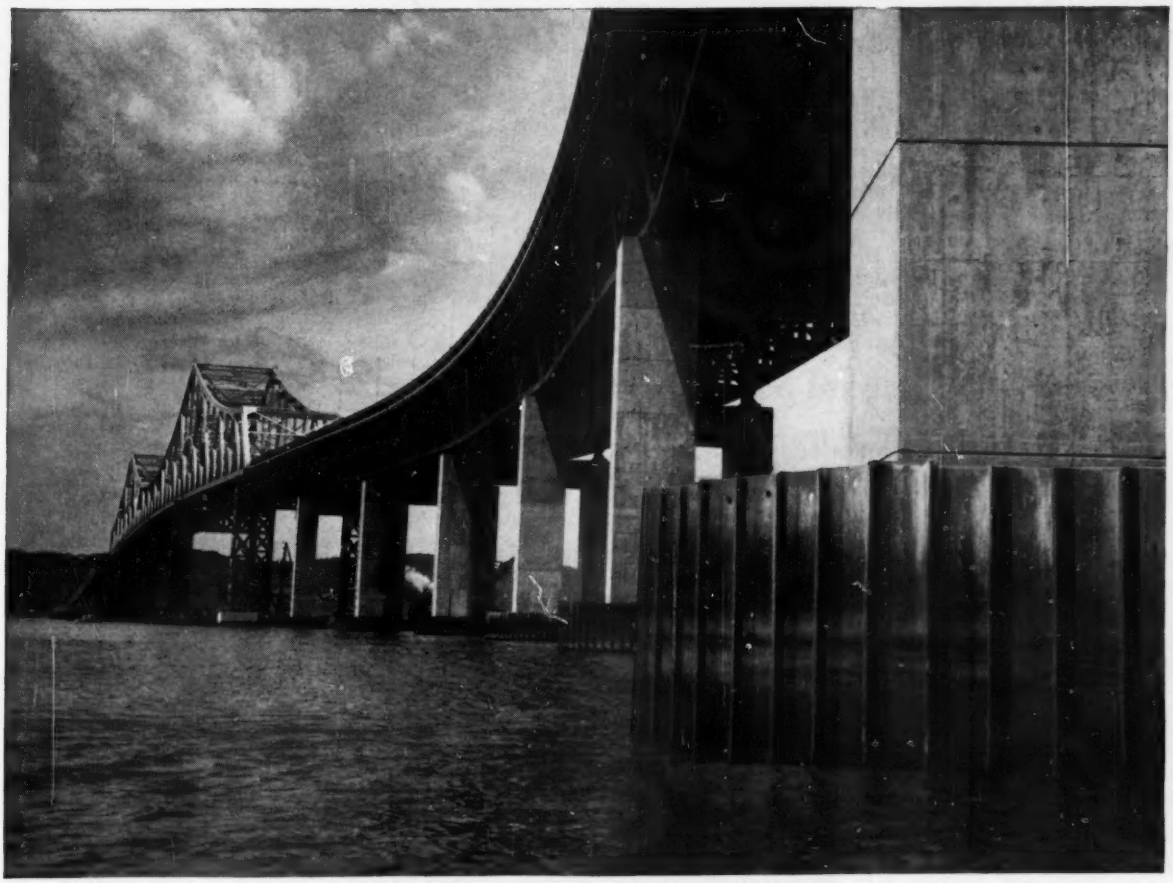
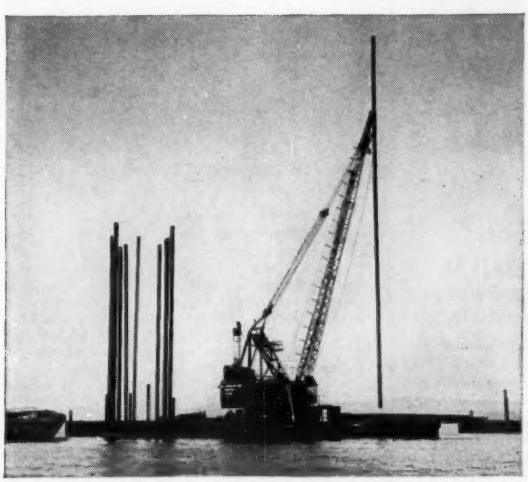


Tappan Zee Bridge as seen from the water level. In construction of the piers nearly 20,000 tons of Bethlehem steel sheet piling and steel H-piles were used.

Steel H-Piles Driven to Rock for Tappan Zee Bridge Piers



Driving 185 ft H-pile for deep-water pier.

The New York Thruway's Tappan Zee Bridge, crossing the Hudson from Nyack to Tarrytown, is nearly 6 miles long—3¼ miles over water. The bridge roadway has six traffic lanes, with a 10-ft center mall. Height of roadway above water is 160 ft.

For the water piers, Bethlehem steel H-piles were used, driven to bedrock in cofferdams built of Bethlehem steel sheet piling. The length of H-piles in these piers varied from 60 to 130 ft. For eight deep water piers, hollow concrete caissons carry part of the load through buoyancy, the balance being taken by pipe caissons with H-pile cores driven to rock. These H-piles were approximately 200 feet in length.

Merritt-Chapman and Scott Corporation placed 17,268 tons of Bethlehem steel H-piles and 2536 tons of Bethlehem steel sheet piling in the construction of the piers for the Tappan Zee Bridge.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

News of Engineers

(Continued from page 26)

Warren E. Wilson is the new dean of the School of Engineering at Pratt Institute, Brooklyn, N. Y. Dr. Wilson goes to Pratt from Pennsylvania State University, where he was George Westinghouse Professor of Engineering Education. Previously, from 1953 to 1954, he was director of the Engineering Division of the Office of Ordnance Research. He is consultant to various industrial organizations, including Curtiss-Wright, Dupont, the Westinghouse Electric Co., and the Sundstrand Machine Tool Co.

Louis J. Capozzoli, Jr., former foundation engineer with Spencer, White & Prentis of New York City, has joined the staff of Engineers Testing Laboratory, Inc., as chief engineer of the Soil Mechanics and Foundation Department. His headquarters will be in Baton Rouge, La.

Robert O. Grimes is one of five members of the staff of H. E. Bovay, Jr., Houston Tex., consulting firm, recently promoted to the status of associate member. Mr. Grimes is project engineer for industrial plants. Other new associate-members are **S. J. Bell, J. R. Maxwell, Guy Furgiuele** and **S. L. Newman.**

John W. Grosskopf, Jr., has taken over new duties as foreman of twin and tank mechanics at the Libbey-Owens-Ford Glass Company's factory at Rossford, Ohio. He joined the company in Toledo in 1952 as a structural engineer and transferred to the Rossford plant when it was started two years ago.

Paul V. Hennessy is new manager of the Los Angeles office of B-I-F Pacific, the West Coast division of B-I-F Industries, Inc. Prior to his promotion, Mr. Hennessy held the position district manager of the Los Angeles office for two years.

Alexander H. Kenigsberg has retired from the Corps of Engineers, Nashville District, after twenty years of service as design engineer on various structures for flood control, navigation and power projects. After an extended tour of Europe, which will include inspection of several engineering projects, Mr. Kenigsberg is planning to resume the practice of civil and structural engineering. He is the author of several current ASCE Technical Publications.

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RECENT BOOKS

(added to the Engineering Societies Library)

American Civil Engineering Practice, Volumes I and II.

Planned as a successor to Merriman's "American Civil Engineers' Handbook," this comprehensive reference work presents the fundamentals and techniques of civil engineering planning, design, and construction. Volume I covers metropolitan and community planning, surveying, traffic, highways, airports, railroads, soil mechanics, site planning, foundations, earthwork, and tunnels, and also contains mathematical tables. Volume II is devoted to hydraulic, sanitary and harbor engineering, and a third volume will deal with masonry, reinforced concrete, steel, and timber structures. Each of the fields covered is treated by a recognized authority. Edited by R. W. Abbett. (John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1956. Various pagings, bound. Each volume $15.)

Air Pollution Handbook

Consisting of sixteen self-contained sections, each accompanied by a list of references, this handbook provides basic source material on both theoretical and practical aspects of the causes, effects, and control of air pollution. It deals with such topics as city planning; plant location; the chemistry and physics of the atmosphere; effects on man, plants, and animals; sampling procedures; analytical methods; equipment for abating pollution; and legislation. Each of the sections has been prepared by an authority in the subject covered. Paul L. Magill is editor. (McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1956. Various paging, bound. $15.)

Berichte des Deutschen Ausschusses für Stahlbau

Heft 19. Versuche an Verbundtragern.

Description and results of full-scale loading tests on five compound (reinforced-concrete and steel) girders. The authors, Otto Graf and Erwin Brenner, also present a number of observations on shrinkage and creep and discuss the effect of preloading on strength. (Stahlbau-Verlag, Cologne, Germany, 1956. 82pp., paper. DM 15.).

Biological Treatment of Sewage and Industrial Wastes, Volume I.

Aerobic Oxidation.

The thirty-three papers contained in this volume are arranged in four parts. Part I reviews the basic principles of bio-oxidation and discusses their application to waste treatment processes. Part II describes the mechanism of oxygen transfer and its application to the design of aeration equipment. Part III and IV deal with the design and operation of typical biological processes for the treatment of municipal and industrial waste waters. Pulp and paper, dairy, phamaceutical, petroleum, and cannery waste treatment methods are discussed in separate papers. Edited by J. McCabe and W. W. Eckenfelder, Jr. Conference on Biological Waste Treatment, Manhattan College, April 1955. (Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N. Y. 1956. 393pp., bound. $10.)

(Continued on page 128)

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The Horton Waterspheroid , "big brother" to the Horton Watersphere®, is a new type of elevated tank, designed for greater capacity and striking appearance. Spheroidal instead of spherical in shape, the Waterspheroid is built in capacities to 500,000 gallons. Base of the structure is designed to occupy a minimum of ground space and be used as a pump house or for storage.

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500,000-gal. Horton Waterspheroid at Northbrook, Ill. It is 135 ft. to the top of the water line and the spheroid is 55 ft. 6 in. in diam.

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Here's a big timesaver on dozing work. It takes just half the time and effort to change from low forward to fast reverse with the Allis-Chalmers HD-6, HD-11, or HD-16 transmission. One simple shift of the gear lever does the job. You gain production time — up to 25 percent on actual test — on jobs calling for a short forward-backward cycle.

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No need to remove transmission or engine, radiator, grille, when servicing or removing an Allis-Chalmers master clutch. This unit can be removed without disturbing adjacent parts. This is also true of other main assemblies — final drive gear, transmission, steering clutches, engine and truck frame. As a result, hours of *costly service and downtime are saved* because of Allis-Chalmers advanced design.

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At least half the cost of an atomic power plant is civil engineering work? This is the estimate of C. V. Roseberry, manager of commercial atomic power activities for the Westinghouse Electric Corporation, whose realistic appraisal of the atomic power picture appears in a Pittsburgh Convention paper in this issue.

• • •

The construction boom is expected to continue in 1957? As the Departments of Commerce and Labor see it, 1957 construction outlays will total almost $46½ billion—an increase of about 5 percent over the record volume of more than $44 billion apparent for 1956. Construction costs will also continue to rise, though at a rate slightly lower than in 1955. The joint estimate of the 1957 construction situation is summarized in the "News Briefs" section.

• • •

The steel industry is completing its second best year? With a staggering output of more than 11,000,000 tons in October, the steel industry by late November headed toward its second most productive year. All indications pointed to a total raw steel output for the year of 114,000,000 tons—the best yet except for the record 1955 output of 117,000,000 tons. Facts and figures are from the American Iron and Steel Institute.

• • •

Research is now the fourth largest industry in the United States? This comes from the Midwest Research Institute which has expanded in the past twelve years from a three-man staff into a $1,000,000 operation. "Obviously," says Fred Stephens, manager of the Institute's Engineering Division, "government and industry have found that research is a prime requisite to the needs of our economy as well as to national defense."

• • •

A two-year government study on highway safety is getting under way? Charles W. Frisk, of the Bureau of Public Roads, will direct the exhaustive study, which was authorized by the Federal Aid Highway Act of 1956. The project will include a pilot study to discover the "real causes" of highway accidents (is it the road, the vehicle, or the driver?) and to determine the effects of horsepower and speed. In announcing the study, Secretary of Commerce Weeks emphasized the 38,300 fatalities that saddened the nation last year, and prophesied that the 1956 toll will probably be in excess of 40,000.

• • •

Electronic techniques are making the Arctic safer for Army tours? New trail markers, developed by the Army's Research and Development Laboratories at Fort Belvoir, consist of two parallel wires and a vehicular-mounted radio-type receiver. An alternating current is fed into the wires which are buried under the snow on both sides of the trail. Indicators in the vehicle give the driver his position within the trail and warn him when the vehicle gets off course—a terrifying possibility in the land of Polar night, blinding snow storms, dense summer fog, and hidden crevasses that are dangerous even when visibility is good.

• • •

In the next ten years we will need 100,000 more scientists and engineers than current training trends indicate we will have? This is the thesis of an authoritative study of the scientific manpower problem prepared by the B. F. Goodrich Company (Akron, Ohio). The alarming shortage could be averted if just 20 to 30 more students out of each 1,000 graduates were trained in science and engineering, the 28-page study says. Estimates are based on a projected U. S. population of 214,580,000 in 1975 and a gross national product of $750 billion.

• • •

The world's highest single-lift lock is under construction in Alabama? This mighty lock—600 ft long and 110 ft wide with a maximum lift of 100 ft—will replace the present three-stage lock now in use at Wilson Dam. The Tennessee Valley Authority and the Army Corps of Engineers are handling the project which was begun last July and is scheduled for completion in March 1960. Working on a 16-hour schedule, heavy equipment is currently excavating and removing over half a million yards of blast rock below the present dam site.

• • •

Unusual construction features mark the Carquinez Strait Toll Bridge Project? These include the biggest cut in highway construction history (11,000,000 cu yd of sandstone and shale); use of false-bottom caissons in the turbulent tidal current; use of high-strength weldable steel for maximum economy; and high-strength bolts for both shop and field connections. Project Engineer Leonard C. Hollister discusses salient features of the interesting crossing in two articles—one of them in this issue and the other in February.

• • •

The new highway program will require materials in astronomical quantity? Major needs for the 13-year period, 1957-1969, include 49 million tons of steel, 1,399 million barrels of cement, 128 million tons of bituminous material, and 9,170 tons of aggregate, according to estimates of the Bureau of Public Roads. At the peak of the program 442,000 men probably will be employed directly on highway construction jobs. The March issue will be devoted to construction aspects of the highway program.

Better Building . . .

AT LESS COST!

Prestressed, Rigid-Frame Structure, Costing $1.72 per Sq. Ft., Finished Months Ahead of Estimated Schedule

● Well worth looking into, in these days of still-rising costs, is the economy potential of prestressed concrete construction. This 100-by-64-ft. office building, two floors and full basement, 18,000 sq. ft. of floor space, quality concrete throughout, was completed months ahead of estimated schedule. Utmost fire-safety and structural soundness, plus earlier occupancy and quicker return on owner's investment. In-place cost of precast prestressed structure, $1.72 per sq. ft.

Precast reinforced columns, 32 ft. on centers, have steel plates welded to girder plate, creating a rigid frame. Hollow girders, precast in halves and assembled into 32-ft.-long members, were post-tensioned with three cables before erection. Three additional continuous cables were added after erection. Inside of girders was filled with grout after tensioning.

Each 6-ft.-wide double-T floor section, supported on girders 33 ft. 4 in. on centers, is stressed with sixteen wire strands, pretensioned and bonded. 'Incor' 24-Hour Cement was used throughout in precasting, for the twin advantage of profitable speed with highest quality.

Required 4500 psi strength was attained after 17 hours steam curing—3-day strengths averaged 6000 psi. 'Incor' was also used in precast wall panels.

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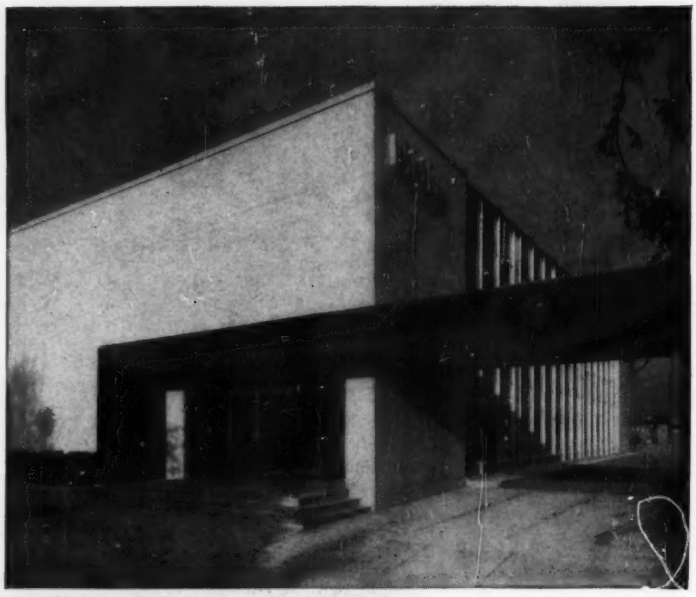

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LONE STAR CEMENT, WITH ITS SUBSIDIARIES, IS ONE OF THE WORLD'S LARGEST CEMENT PRODUCERS: 18 MODERN MILLS, 38,000,000 BARRELS ANNUAL CAPACITY

Typical of contemporary design is Chrysler Building East, in New York, N. Y. Characteristics of modern building extend much deeper than straight lines and skins of metal and glass. Multiplicity of electrical and mechanical installations, cellular floors, and long clear spans, are all part of change that has taken place in recent years.

CONTEMPORARY DESIGN

ITS EFFECT ON THE CONSTRUCTION COST OF THE MODERN OFFICE BUILDING

H. C. Turner, Jr., Turner Construction Company, Pittsburgh, Pa.

Contemporary design—what is it? Some may think it is simple, functional design. Others may say it means a glass building or a metal covered building. Still others may think of it from the standpoint of wide spans, air-conditioning, and fluorescent lighting.

I believe that contemporary design is that design which results from a desire on the part of owners, architects, and engineers for distinction and individuality. It comes from a desire for greater efficiency, usability of space, flexibility, and expandability. Such designs inevitably rely on new ideas, new materials, new methods.

Engineers—structural, mechanical, and electrical—are now responsible for over 50 percent of the design of a building. Whatever their specialty, engineers have many tough problems to solve in trying to carry out the ideas that the architect and owner may develop. In addition, both the general contractor and the subcontractor are faced with many problems in attempting to put together and install the new materials and carry out the new or improved designs.

Quite frankly, I believe that both the architect and the engineer should make greater use of the services of a competent builder and bring him into the

picture as a consultant from the practical construction standpoint, to make sure that the complexities of assembly and installation have been thoroughly thought through and that the result will be achieved in the most practical and economic manner.

To discuss the subject of cost, it is necessary to establish a basis for comparison, so let us assume that the structure under discussion is a contemporary office building. It is a multistory structure, similar to those built in Pittsburgh in the past ten years and now being constructed in New York, Chicago, and elsewhere. It has simple lines, an exterior of metal and glass or a combination of brick, metal and glass, and of course it is air-conditioned, has accoustical ceilings, fluorescent lighting, and flexibility in its interior arrangements. I propose to break this building down into several basic major parts—foundations, structural frame, walls and windows, floor covering, ceilings, air-conditioning, electrical work, and elevators.

Foundations do not have a major effect on design, except to the extent they may affect the height of the building and its cost. If rock is only a short distance below the surface, as in midtown New York, the cost of foundations for a large office building will amount to $1.00 to $1.25 per sq ft of the building's floor area. However, if we have a combination of deep rock and sand and water, such as is found in downtown New York, the foundation cost may well approach $5.00 per sq ft of floor area. This cost factor must be considered in the economic picture when purchasing property and when determining the rental return, or in estimating the cost of owner occupancy.

The **structural frame** for a tall building is naturally of structural steel, but in buildings that are only 10 to 15 stories in height, the concrete frame may well serve the purpose more economically. However, reinforced concrete does not readily lend itself to long spans.

The structural steel frame may vary considerably in cost depending on column spacing and floor loads. Also, the cost will increase considerably for tall, thin buildings, because of the necessary allowance for wind stresses. If columns are placed on the outside of the exterior wall, as is now being done on several of the new buildings, and long interior spans are used, the cost is considerably higher. The significant factor is the number of pounds of steel per square foot of floor area rather than the price of the steel. For instance, in a 40-story building with a large base and normal column spacing, the structural steel amounted to 24 lb per sq ft of floor area, whereas in a slender 60-story building, with exterior columns and 60-ft spans, the steel amounted to 42 lb per sq ft of floor area. With steel costing around 18 cents per lb erected, it can very quickly be seen what a substantial difference in cost this would mean. However, it is interesting to note that the clear space provided by the outside columns and long spans increases the useable area and gives greater flexibility for interior layouts. These factors may well offset the increased cost of the steel.

There is a definite trend toward longer spans in the better built buildings, and the live floor load has been increased to permit the use of moderately heavy office equipment. Thus it can be seen that the cost of the steel frame may vary from $3.00 to $8.00 per sq ft of floor area.

Story heights in modern buildings have been decreased and now are about 11 ft 6 in. to 12 ft. The air-conditioning and piping is more tightly fitted under the floor slab with the result that ceiling heights run from 8½ to 9 ft.

Many of the newer buildings are using cellular-type steel floors, which provide more flexibility for electric outlets. In most cases, however, lightweight concrete, including under-floor ducts, is more economical unless a plus value is given to the factor of flexibility for electrical and telephone outlets. There has been some indication recently that the cellular type of steel decking will be modified to reduce its cost. Although the new product will provide somewhat less flexibility, it will make the cost more nearly comparable to that of the more conventional concrete slab and fill.

Walls provide one of the principal opportunities for variation in the character of a building. We are all familiar with the brick, granite, and limestone facings used on the buildings of the past. We have also seen the recent developments in aluminum, stainless steel, and glass. In Pittsburgh, there is the Alcoa Building, with its aluminum facing, the Mellon–U. S. Steel Building, which has a combination of limestone piers and stainless steel windows and spandrels, and the Gateway Center Building, which has chrome stainless-steel spandrels. In New York there are a number of examples of buildings with an aluminum skin and one large building with stainless-steel skin. We have glass curtain walls, as illustrated by Lever House and the UN Headquarters, and there are now a number of buildings under construction in various parts of the country which utilize both stainless steel and glass facings. There is a considerable variation in the cost of these exteriors, as noted in Table I.

TABLE I. Relative costs of curtain wall materials

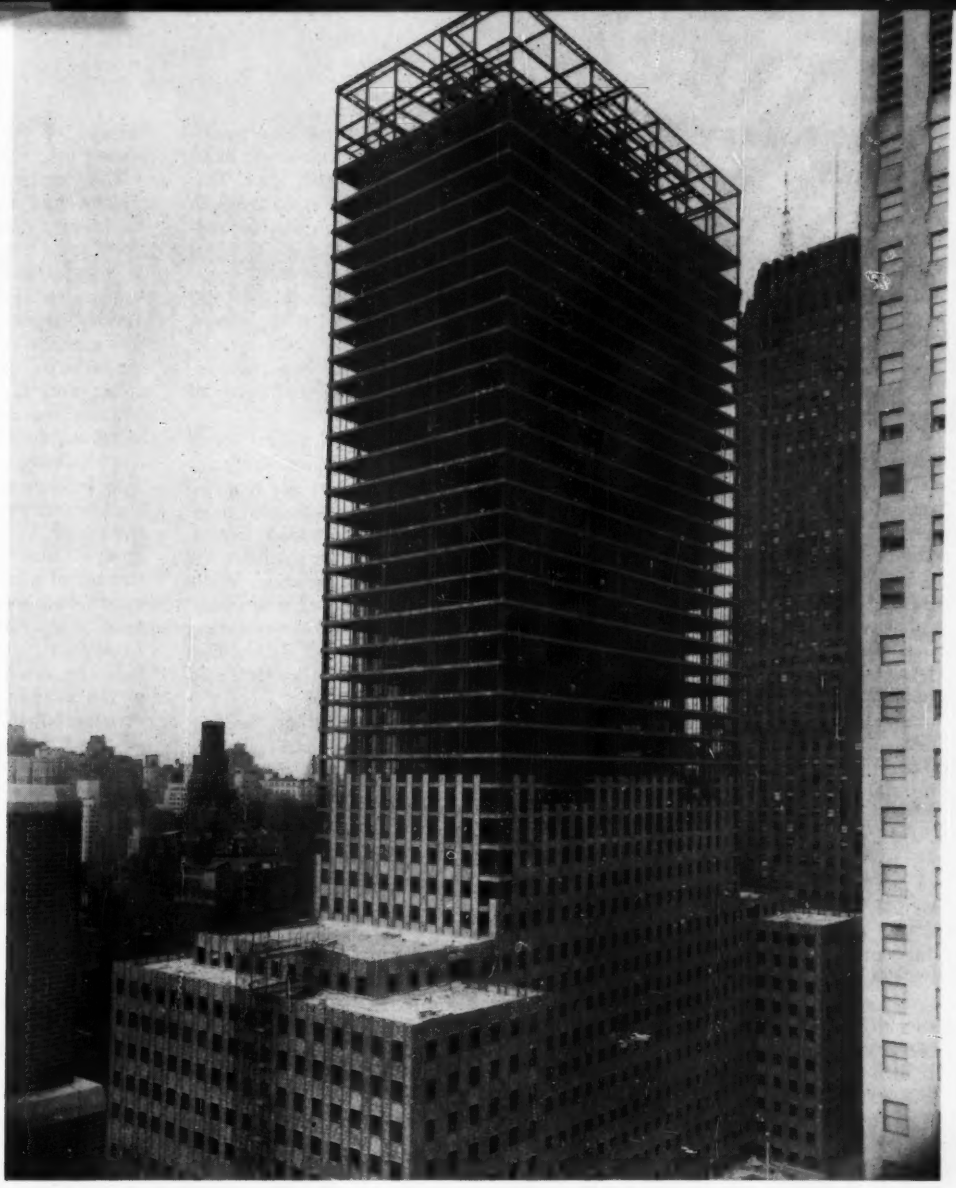
Facing Material	Cost per Cu Ft of Wall Area
Brick wall	$4.00 to $5.00
Limestone wall	6.00 to 7.00
Aluminum wall*	7.00 to 8.00
Stainless steel wall, mill finish*	7.00 to 8.00
Stainless steel wall, polished*	10.00 to 11.00
Porcelain enamel steel*	6.50 to 7.50
Glass wall	10.00 to 11.00

*Includes masonry back-up and insulation.

Combinations of the materials mentioned will have varying costs, and in the case of an aluminum-frame glass wall using stock material, the cost may be somewhat lower than that listed. Furthermore, if the building is constructed in an area where the building code does not require a masonry back-up, the cost will be less. There are other factors, of course, such as a reduction in the tonnage of structural steel required because of the lighter weight of the wall, but this would not materially affect the relative costs given in Table I.

Another interesting factor is the effect of different types of walls on the cost of air-conditioning. Studies indicate that a glass window surface substantially increases the cost of air-conditioning as compared with a brick wall or a metal wall that is properly insulated. For a climate such as that of Pittsburgh, a glass wall as compared with a 13-in. brick wall will add about $4.00 per sq ft of wall area to the cost of the air-conditioning installation. In other words, if an exterior wall is about 75 percent glass window area, and if the total wall area is equal to one-third of the floor area of the building, the first cost of the air-conditioning may increase by as much as $1.00 per sq ft of floor area. Glass, of course, has other qualities that many consider desirable.

Windows that are double hung are giving way to those that are either pivoted or fixed. A typical double-hung window 4 x 6 ft, in carbon steel, costs about $3.00 per sq ft of opening. An aluminum double-hung window of similar size costs about $4.00 per sq ft. A pivoted stainless-steel window of similar size will cost about $6.00 per sq ft, and an identical pivoted window in aluminum, about $4.00 per sq ft. In some contemporary office buildings, we have framed openings with fixed glass.



Steel is still predominant structural material for tall office buildings. Pounds of steel per square foot of floor area can vary widely depending on span lengths and slenderness of building.

Significant trend in recent years has been widespread use of metallic or glass skins for enclosing structures. Here workmen position two-story stainless steel panel for Socony Mobil Building in New York. Speed of erection and light weight have been important factors in popularity of these wall materials.

Such an opening in stainless steel would cost around $4.00 per sq ft and in aluminum about two-thirds as much. However, with fixed glass it is necessary to provide special window-cleaning equipment and such equipment may well cost from 60 cents to $2.50 per sq ft of wall area, depending on the shape and height of the building.

The development of thiokol appears to be an important factor in the development of weather-tight metal and glass walls and windows. An architect from Boston noted recently that he had been having a great deal of trouble with leakage on a building in Boston, since the calking compound seemed to disappear. On further study he found that the crows apparently liked this compound and were picking it out. Thus it is evident that new developments in buildings are always subject to unforeseeable circumstances.

Floor coverings today include quite a wide range of materials but these are not particularly new. Asphalt tile is the lowest in cost, with linoleum, rubber tile, and vinyl tile all costing more in that order. Carpeting, of course, is still more expensive.

Ceilings today are all accoustical with fluorescent fixtures and air-conditioning outlets. However, there is considerable variation in the materials and fixtures used, and consequently in the cost. There are luminous, semiluminous or plastic, and open-baffle-type ceilings.

Air-conditioning is standard in all modern buildings but its effectiveness varies as well as its cost. If the exterior wall is largely glass, it is generally necessary to distribute the air-conditioning horizontally instead of providing vertical ducts alongside of the columns or piers. Horizontal distribution may increase the cost from 50 cents to $1.00 per sq ft of floor area, as compared with vertical distribution along the exterior wall. Also, the amount of fresh air that is introduced into the air-conditioning system affects the amount of equipment required. In the more cheaply designed systems only 10 percent of fresh air may be used as compared with as much as 25 percent in the better systems. This would affect the air-conditioning cost by an amount equal to $1.00 per sq ft.

The amount of **electrical work** incorporated in today's buildings is considerably greater than that of 20 years ago. We have better lighting, better fixtures, better distribution, plus an allowance for the added power load needed to serve office machine equipment. The cost may run from $2.00 to $3.00 per sq ft of floor area. This would include under-floor ducts which may vary considerably in cost depending on whether they are made of metal or of fiber, whether they are single, double or triple systems, and also whether the spacing is 4 ft on centers, 6 ft, or more. In addition, the type of fixtures selected has an important effect on cost, as well as the degree of intensity desired.

The **elevators** being installed today are more than 90 percent automatic; in other words no operators are required and naturally they are somewhat more costly. However, this added cost is minor as compared to the saving in the operating cost of the building. While there has been some confusion when tenants first used these operatorless elevators, experience has shown that people like them after they get used to them.

The cost of the plumbing, heating, ventilating, electrical and elevator equipment that goes into the modern office building is vastly more than the cost of these same items in the buildings constructed in the 1920's. The cost of these facilities now amounts to 40 to 45 percent of the total cost of the building as compared with 20 to 25 percent in the previous period. This is of course due to air-conditioning, more extensive electrical requirements, and better elevators.

The **modular system,** now well known, may have a material effect on the cost of a building. If the column spacing only is modular, there is little if any added cost, but if the heating, air-conditioning, ventilating, and electrical facilities must fit into a 5- or 6-ft module, then the increased cost of providing this flexibility may amount to a dollar or more per sq ft of floor area. I do not mean to infer by this comparison that a modular system is not desirable.

All of us in the building industry have been concerned with the tremendous increase in building costs during the past twenty years and with the probability that these costs will continue to increase in the years ahead. We are not able to attain the degree of mechanization, mass production or automation that other industries have achieved. Each building project is at a different site, each must be constructed under varying conditions and with many combinations of materials and characteristics. Labor is transient and does not normally or readily follow the shifting locations of the employer. Construction today is primarily an assembly of materials and equipment, and the more we can prefabricate efficiently, off the site, the better we can control field costs.

Also, construction labor today is less efficient and less productive than it was twenty years ago and there is not likely to be any material improvement as long as we have substantially full employment. However, the two factors directly responsible for the substantial cost increase of recent years are: (1) the decreased purchasing power of the dollar, and (2) the fact that today's building contains so many more and improved facilities for both comfort and efficiency.

As building costs have gone up there has been an increasing attempt to save space with the result that a minimum area is allowed for the tremendous amount of piping, conduits, and ducts in today's building. This has made our work more complicated and difficult. In addition, with metal and glass buildings, the exterior really becomes part of the interior and the tolerances are extremely fine. In fact you might say we have a skin-tight structure which must be carefully put together. As one man remarked, "It is like a sheer nightgown covering a beautiful figure."

The contemporary office building has a lightness and freshness which is usually quite attractive and appealing. Whether the current vogue for large glass areas will be permanent, I do not know. But it is good to have these new architectural and engineering developments. It is progressive and I for one certainly support those who are seeking newer, better, and more attractive ways to build. I believe we will see more buildings with combinations of metal and glass skins, with outside columns and with wide interior spans.

My principal aim in this discussion is not to discourage the development of new ideas, new materials, and new methods, but rather to be realistic in appraising the problems they involve, the length of time that is needed to develop something new, and an awareness of the cost of such new features.

The present-day building is as different from that built several decades ago as the modern automobile is from the Model-T Ford. Let us continue to encourage the development of finer and more useful buildings and let us persuade the owners who must pay for them to support the architects and engineers who design them.

(This article is based on the paper presented by Mr. Turner at the ASCE Pittsburgh Convention, before the Construction Division session presided over by Walter L. Couse, Chairman of the Division's Program Committee.)

ADEQUATE HIGHWAYS

for America

REX M. WHITTON, M. ASCE

President, American Association of State Highway Officials; Chief Engineer, Missouri State Highway Commission, Jefferson City, Mo.

Until recently, adequate highways for America seemed little more than a dream of the nation's highway engineers and other farsighted people who recognized early the mounting highway transportation problem facing the nation. The picture has changed sharply now. The Federal-Aid Highway Act of 1956, passed by the Congress and signed by the President, charts the course by which we can obtain such highways in the future.

Given the necessary tools, American ingenuity can surmount almost any obstacle. We have proved that time and time again in war and in peace. In recent years, as the highway situation has moved to the forefront as the nation's number one problem, the principal tool needed to meet it—money—has not been available. The Federal-Aid Highway Act of 1956 provides that tool, and the next 13 years should see us making giant strides toward the reality of adequate highways.

Just as the Federal Aid Highway Act of 1916 actually caused the establishment of many of the state highway departments and sparked the road building surge of the 1920's and early 1930's by furnishing certain sums of money to each state on a matching basis through properly created state highway departments, so the 1956 Act will go far toward providing the incentive for the modernization and extension of our highways.

The 1956 Act may well be considered to have four major provisions. First, it amends the Act of 1916 to fit today's highway needs. Second, it sets up a 13-year program for completing our Interstate System. Third, it makes provision for modernizing and expanding the Primary, Secondary and Urban Highway Systems and for roads and trails in specific national areas. Fourth, and finally, it sets up the machinery by which these programs are to be financed.

Today's needs

Breaking these provisions down for discussion purposes, we note first that the 1916 Act authorized the Secretary of Agriculture "to cooperate with the States through their respective State Highway Departments, in the construction of rural post roads; but no money apportioned under this Act to any State shall be expended therein until its Legislature shall have assented to the provision of this Act."

The Act also provided that "the Secretary of Agriculture and the State Highway Department of each State shall agree upon the roads to be constructed therein and the character and the method of construction: Provided, that all roads constructed under the provisions of this Act shall be free from tolls of all kinds."

It should be noted further that this early bill defined a rural post road as "any public road over which the United States mails are or may hereafter be transported" but excluded "every street and road" in cities and towns of 2,500 or more population except those along which houses average more than 200 ft apart.

The partnership which this Act created between the Federal Government and the states, and which the 1956 Act continues, has achieved much through the years. The original Act has been amended many times since, to fit it to developing trends and traffic needs, and to provide for city dwellers as well as those residing in rural areas. The overall result has been that this nation today is recognized as having the finest highway system in the world, although admittedly it is inadequate for our current traffic demands and urgently needs attention to fit it to future requirements.

THIS IS THE FIRST PROJECT
IN THE UNITED STATES
ON WHICH ACTUAL CONSTRUCTION WAS STARTED
UNDER PROVISIONS OF THE NEW
FEDERAL AID HIGHWAY ACT OF 1956
MISSOURI STATE HIGHWAY COMMISSION
CAMERON, JOYCE & COMPANY
CONTRACTORS

First project on which dirt actually flew under provisions of 1956 Federal-Aid Highway Act, was in St. Charles County, Missouri. Here a finished section of the expressway is seen in background.

The Interstate System

Turning to its second major provision, the 1956 Act, in setting up the Interstate System program, says "it is the intent of Congress that the Interstate System can be completed as nearly as practicable over a 13-year period, and that the entire system in all the States be brought to simultaneous completion."

To accomplish this goal the Act, over the 13-year period, authorizes the appropriation of $24,825,000,000 "for the purpose of expediting the construction, reconstruction or improvement, inclusive of necessary bridges and tunnels, of the Interstate System, including extensions thereof through urban areas, designated in accordance with the provisions of Section 7 of the Federal Aid Highway Act of 1944." This total authorization is composed of annual allotments ranging from $1 billion the first year to a top annual amount of $2.2 billion as the program moves forward.

The division of cost for building this Interstate System will generally be 90 percent federal aid and 10 percent state funds. This ratio should provide the real impetus on the part of the states to get the job done. The money will be distributed during the first three years on the basis of two-thirds according to population, one-sixth according to area, and one-sixth according to total post-road mileage within each state. For the remaining ten years of the program, the funds will be distributed on the basis of need, that need to be determined by estimates of costs based on studies and reports made at stated intervals.

This Interstate System of highways is composed of 40,000 miles of arterial routes, plus another 1,000 miles added by the 1956 Act but as yet undesignated. The system as a whole unquestionably is the most important highway network in the United States. It is nation-wide in coverage. It carries more traffic per mile than any other comparable system. It includes the roads of greatest significance to our nation's peacetime economy and to its national defense. It passes through all 48 states, joins 90 percent of all cities of 50,000 population or over, and connects 42 of the state capitals. When the system is completed, it probably will carry at least 25 percent of our total traffic.

The 1956 Act provides that "the geometric and construction standards for the Interstate System shall be those approved by the Secretary of Commerce in cooperation with the State Highway Departments. Such standards shall be adequate to accommodate the types and volumes of traffic forecast for the year 1975." Certainly this is a clear mandate from Congress to build the Interstate System to a high standard.

The several states, working through appropriate committees of the American Association of State Highway Officials and with officials of the Bureau of Public Roads, have agreed on standards for the Interstate System, and these standards have been approved by the Secretary of Commerce. Among other things, these standards require that the right-of-way on all sections of the Interstate System be secured with controlled access rights and that the great majority of the mileage be constructed by separating the lanes of traffic in opposite directions. These two features—controlled access and dual-lane construction—are the two greatest engineering factors in highway safety. They will have critical attention as this system is built.

There will be no railrad crossings on the thruways. Highway crossings at grade will be eliminated except in rare instances in isolated sections. When the system is completed the highway user will be able to cross the United States without being halted by a red light or a stop sign.

The design speed of all highways in the Interstate System is to be at least 70, 60 and 50 miles per hour for flat, rolling, and mountainous topography respectively, and depending upon terrain and development. The design speed in urban areas is to be at least 50 miles per hour. For design speeds of 70, 60 and 50 miles per hour, gradients generally are to be no steeper than 3, 4 and 5 percent respectively. However, gradients 2 percent steeper may be provided in rugged terrain.

Traffic lanes on the Interstate System are to be not less than 12 ft in width. Medians between lanes of traffic moving in opposite directions must be at least 36 ft in width in rural areas of flat and rolling topography, and at least 16 ft in width in urban or rural mountainous areas.

Lanes of traffic moving in opposite directions must be separated where the DHV (1975), that is, the design hourly volume in 1975, exceeds 700 vehicles, or exceeds a lower two-lane design capacity applicable for conditions on a particular section. For lower traffic volumes, two-lane highways may be built but they must be so designed and so located on the right-of-way that an additional two-lane pavement can be added in the future to provide a divided traffic facility.

Shoulders usable by all classes of traffic in all weather must be provided on the right of traffic. Usable width of those shoulders is to be not less than 10 ft except in mountainous terrain, where it may be 6 ft.

Right-of-way widths are required to be sufficient to construct and properly maintain the facility. No final limits are fixed except that minimums are: 150 ft for two-lane and four-lane divided pavements without frontage roads, and 250 ft with such roads; 175 ft for six-lane divided pavements without frontage roads, and 275 ft with such roads; and 200 ft for 8-lane divided pavements without frontage roads and 300 ft with such roads.

Primary, Secondary and Urban Systems

The third major provision of the 1956 Act aims at modernizing and expanding the Primary, Secondary and Urban Highway Systems, and roads and trails in specific national areas, by authorizing increasingly enlarged appropriations for each of the years ending June 30 in 1957, 1958 and 1959. It would seem to be the intent of Congress to continue such increased appropriations throughout the period of the Interstate System program.

This provision assures a complete, well-rounded highway program—one that will benefit every highway user whether he is merely making a visit to his neighborhood store, his school, his church, his civic club, or is traveling across the country.

Additional funds of $125,000,000 were authorized for the Primary, Secondary and Urban systems in 1957. Apportionments are fixed at $850,000,000 for 1958 and $875,000,000 for 1959. The Act specifies that 45 percent of these increased funds shall go for Federal-Aid Primary Highways, 30 percent for Secondary routes, and 25 percent for extensions on these systems within urban areas.

To help make the Act more workable on these three systems, states are permitted to transfer up to 20 percent of their apportionment from one of these systems to either of the others, to facilitate the proper carrying out of the desired and necessary program in a state. Such a provision certainly helps to add flexibility to the program.

Federal funds for expenditures on these Primary, Secondary, and Urban Systems must be matched by the states on a 50-50 basis. The federal funds will be prorated to the states on the existing formula of one-third each for area, population, and total rural post-road mileage in the state.

Increasing amounts of federal-aid for the Primary, Secondary and Urban Systems, together with state funds formerly used on the Interstate System, certainly will provide a very definitely

stepped-up improvement program here. Just as for the Interstate System, high standards of construction will also be used on the Primary, Secondary and Urban Systems, those standards to be controlled by the predicted traffic volumes.

Where money will come from

Financing these added authorizations in federal-aid funds for highways represents the fourth major provision of the 1956 Act. This has been accomplished by increasing the federal tax on gasoline, diesel fuel, and special motor fuels by 1 cent per gal; by increasing the tax on tires by 3 cents per lb; by increasing the tax on new trucks, buses and trailers; by a new tax of 3 cents per lb on retread rubber; and by a new use tax of $1.50 per thousand lb on vehicles weighing more than 26,000 lb.

The financing provisions of the 1956 Act also make one far-reaching change in current methods in that a special highway trust fund is created into which highway user taxes must go. These funds then can be used only to finance the Federal Aid Highway program provided for in the Act.

It has been estimated that these new highway taxes will cost the average highway user about $8.60 additional per year, but that same highway user will profit from this expenditure. The nation's average annual travel mileage is 9,400 miles for each highway user. It is estimated that each user will save one cent a mile, or $94 a year in lower operating costs on his car through relief from present congestion and through various design improvements on the highways which will make for greater ease and mobility of travel.

We must not overlook the greatly increased safety benefits to be attained through improvements aimed at lessening traffic risks. Our highway accident toll has become a national tragedy and disgrace—with more than 38,000 people killed last year, to say nothing of the thousands of others who were maimed for life and the millions of dollars lost in property damage. In fact, the situation has become so acute that in Missouri the Governor declared a "state of emergency" and called out the National Guard's Military Police units to assist the Highway Patrol in policing Missouri highways during the Labor Day week end, to try to cut the traffic toll.

It is estimated that, by bringing the Interstate System of highways up to adequate standards, some 3,500 lives will be saved each year. As the states expand the program to make their other highways adequate also, the number of lives saved will become much larger, to give us vast humanitarian benefits.

Some may ask when we will begin to get the benefits of this great program. The people must bear in mind that this is not an overnight job. Some relief will come in a year or 18 months, when the first jobs are being completed, but on the whole this is a long-haul job. It is most likely that, after two or three years, projects will be completed in a continuing flow, with the impact of the program becoming more evident each year.

What about the future? It has been the history of road building that as one good road is built, it serves as an impetus to bring others. In my opinion, this new federal-aid highway program will be just the beginning of a gigantic road building era.

Certainly the completion of the Interstate System now designated is not the ultimate answer. As highway users see the benefits of these planned-access divided highways connecting, leading into, and around our cities, population centers and industrial areas, they are going to demand more and more of this type of highway until finally most of our arterial state routes will have to be of the same design.

We have already experienced that demand in Missouri. We have made good progress toward providing a divided pavement on two Interstate highways, U. S. routes 40 and 66 across Missouri. Now cities and highway users along U. S. Route 71 between Kansas City and Joplin (not now an Interstate route) are pressing for this type of improvement. We know there will be others to follow. We know that, as we move into the future, the type of our highways will continue to be dictated by the will of the people and the development and use of the motor vehicle.

This new federal-aid highway bill undoubtedly will go down in our history books as the most forward-looking and far-reaching legislation ever enacted in this nation. The impact of the vast road building and modernization program it makes possible will be so great that its results will appear unbelievable. Certainly the final benefits will be felt for years in the future.

In the final analysis, this legislation will do many things for us by providing modern, adequate highways for America. Here are just a few:

It will save lives and reduce our traffic jams.

Ease of driving will make travel less tiring.

More jobs will be provided, not only in actually constructing the highways but also in various supporting industries.

Community development will be given added life.

Decentralization of industry will be encouraged.

Property values along the highways will increase and more business opportunities will be created.

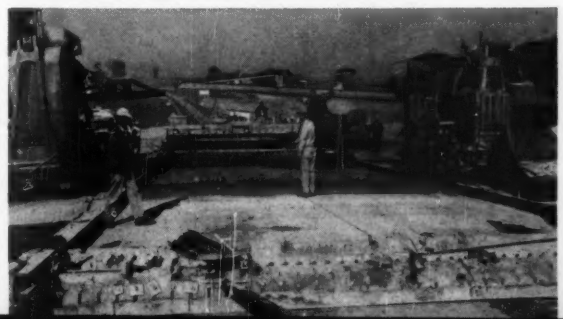
Modern highways will be invaluable to our military forces in the defense of our country in the event of war.

Success of the highway program will require complete cooperation from all sources. The states, of course, will have to provide their share of the matching funds if the over-all program is to be carried to a successful conclusion. We in the engineering profession, as well as all others who have any part in the effort, must bend every effort to achieve the desired goals.

We are on our way toward adequate highways for America.

(This article has been prepared from Mr. Whitton's address at the ASCE Pittsburgh Convention, before the Highway Development Luncheon, presided over by Carl B. Jansen, Chairman of the Convention Technical Program Committee.)

Grading operations are seen under way—at left below—on expressway in St. Charles County, Missouri. This was first project to be put under actual construction under provisions of Federal Aid Highway Act of 1956. At right, paving progresses on same project.



Grid bridge design

LOUIS BALOG, Consulting Engineer, Binghamton, N. Y.

Rigid transverse framing of girders affects the distribution of the loads placed at the framed system, designated a grid. The transverse framing may be a slab or it may consist of one or more individual cross frames. The girders may have negligible torsional rigidity, or they may be rigid torsionally. The bridge design specifications of the American Association of State Highway Officials (AASHO) do not consider these structural characteristics which significantly affect the distribution of the live load between the girders. They assign design live loads to the girders according to their spacing, irrespective of the rigidity characteristics of the grid. This practice results in different factors of safety for bridges of various arrangements and materials, generally penalizing monolithic construction and long-span girders.

In Fig. 1 are shown load distribution diagrams for girders with negligible torsional stiffness (Lines 1) and for girders of perfect torsional stiffness (Lines 2), connected by a perfectly rigid center diaphragm. The distribution diagrams are straight lines; therefore the two end ordinates define the diagrams. For girders having negligible torsional stiffness, these ordinates are:

$$t_1 \ldots t_n = \frac{1}{n} \pm \frac{3[n-(2i-1)]}{n(n+1)} \quad (1)$$

For girders of perfect torsional stiffness, the ordinates are equal:

$$t_1 = t_2 = t_{n-1} = t_n = 1/n \ldots (2)$$

If l denotes the span length; a, the spacing of the girders; b, the width of the bridge; λ, the spacing of the diaphragms; EI_g, GI'_g and EI_c, GI'_c, the flexural and torsional rigidities of the girders and the diaphragms respectively, then the grid stiffness is characterized by the following expressions.

For flexural grid stiffness:

$$z = (l/2a)^3 \frac{I_c}{I_g} \quad (3)$$ (Enyedi 1928, Ostenfeld 1930, Leonhardt 1938, Homberg 1949)

$$\vartheta = \frac{b}{2l} \sqrt[4]{\frac{I_g \lambda}{I_c a}} \quad (4)$$ (Guyon 1946)

$$\alpha = \frac{12}{\pi^4} \left(\frac{l}{a}\right)^2 \frac{I_c}{I_g} \quad (5)$$ (Hendry and Jaeger 1955)

For torsional grid stiffness:

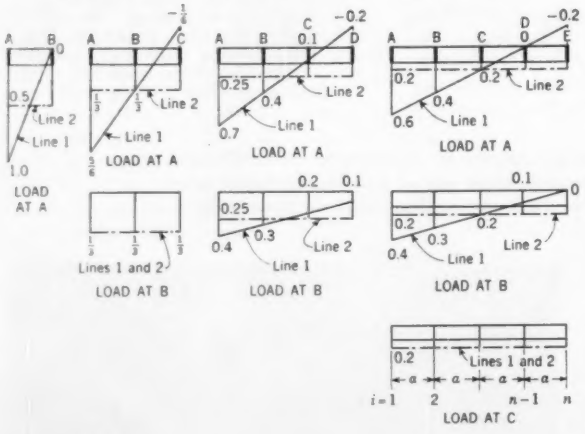
$$\alpha = \frac{G\left(\frac{I'_g}{a} + \frac{I'_c}{\lambda}\right)}{2E\sqrt{\frac{I_g I_c}{a\lambda}}} \quad (6)$$ (Massonnet 1950)

$$\beta = \frac{\pi^2}{2} \left(\frac{a}{l}\right) \frac{GI'_g}{EI_c} \quad (7)$$ (Hendry and Jaeger 1955)

The extreme values of z (Eq. 3) and of α (Eq. 5) are infinite. The extreme value of ϑ (Eq. 4) is zero; of α (Eq. 6), unity; and of β (Eq. 7), infinite. The corresponding diagrams of load distribution are shown in Fig. 1.

The effects of the stiffness characteristics of various grids on the stresses in their girders will be shown by comparison of computed and measured load distributions and moments with those specified by the AASHO.

FIG. 1. Diagrams of load distribution are for extreme stiffness conditions of girders which are framed by a rigid diaphragm.



Load distribution by various methods

The differences between the girder loads obtained by various methods will be illustrated by a reinforced concrete four-girder bridge framed by a center diaphragm, where $l = 91.86$ ft, $a = 0.1\,l$, $b = 36.75$ ft, $I_c/I_g = 0.5838$, $GI'_g/a = 0.0261$, $GI'_c/\lambda = 0.0022$. These values result in grid stiffness parameters as follows: $z = 72.98$ (Eq. 3), $\vartheta = 0.342$ (Eq. 4), $\alpha = 71.92$ (Eq. 5), $\alpha = 0.171$ (Eq. 6), and $\beta = 0.00907$ (Eq. 7). The ordinates of the load-distribution diagrams, computed by various methods, are listed in Tables I and II.

The ratios, $l/2a$, I_c/I_g and GI'_g/EI_g characterize the geometry and stiffness relations of grids. Similarly to the flexural parameter z (Eq. 3), the torsional grid stiffness can be expressed by the parameter τ, neglecting the effect of the torsional stiffness of the diaphragm

$$\tau = (l/2a)^3\, GI'_g/EI_g \ldots (8)$$

Introducing this torsional stiffness parameter into the expression of the ordinates corresponding to an assumed perfectly rigid diaphragm, Eq. 1 becomes:

$$t_1 \ldots t_n = \frac{1}{n} \pm \frac{3[n-(2i-1)]}{n(n+1)+\tau} \quad (9)$$

With the numerical values of the example, $n = 4$, and $\tau = 13.41$ (Eq. 8), Eq. 9 results in ordinates:

For Girder A, t_A and t_D =

$$\frac{1}{4} \pm \frac{9}{20 + 13.41} =$$

0.5191 and $= -0.0194$, Fig 2(*a*).

For Girders A and B: $\left\{\begin{matrix} t_B \text{ and } t_C \\ t_A \text{ and } t_D \end{matrix}\right\}$ =

$$\frac{1}{4} \pm \frac{3}{20 + 13.41} =$$

0.3398 (t_B and t_A) = 0.1602 (t_C and t_D).

For Girder B, t_B and t_C =

$$\frac{1}{4} \pm \frac{1}{20 + 13.41} = 0.2800 \text{ and } = 0.2200, \text{ Fig. 2}(b).$$

Considering now the actual flexural and torsional grid stiffnesses as expressed by the parameters z (Eq. 3) and τ (Eq. 8), ordinates for the unit-load-distribution diagram are obtained as follows:

For Girder A, t_A and t_D =

$$\frac{5 + z}{10 + 4z} \pm \frac{3 + 9z}{6 + 20z + \tau z} \quad (10)$$

$$\frac{78}{302} \pm \frac{660}{1{,}466 + 979} = \begin{cases} 0.5282 \\ -0.0116 \end{cases}$$

For Girders A and B, $\left\{ \begin{matrix} t_B \text{ and } t_C \\ t_A \text{ and } t_D \end{matrix} \right\}$ =

$$\frac{z}{10 + 4z} \pm \frac{3z}{6 + 20z + \tau z} \quad (11)$$

$$\frac{73}{302} \pm \frac{219}{2445} = \begin{cases} 0.3313 \ (t_B, t_A) \\ 0.1521 \ (t_C, t_D) \end{cases}$$

For Girder B, t_B and t_C =

$$\frac{5 + z}{10 + 4z} \pm \frac{3 + z}{6 + 20z + \tau z} \quad (12)$$

$$\frac{78}{302} \pm \frac{76}{2445} = \begin{cases} 0.2894 \\ 0.2272, \end{cases} \text{ Fig. 2}(d)$$

The evaluation of the load-distribution diagrams for H 20-S 16–44 truck loading, and for H 20–44 lane loading, are shown in Fig. 2 and in Table III.

The dimensions of a reinforced concrete four-girder bridge with a center diaphragm were: $l = 51.18$ ft, $a = 7.45$ ft, $r = I_A/I_B = 1.75$, $I_c/I_B = 0.52$, $z = 21.2$ (Eq. 3), $G/E = 0.5$, $\tau_{A \text{ and } B}$ =

TABLE I. Ordinates of load distribution diagrams without considering torsional grid resistance

Method	Girder A				Girder B			
	A	B	C	D	A	B	C	D
Leonhardt, 1938	0.7085	0.3911	0.0923	−0.1919	0.3911	0.3102	0.2064	0.0923
Guyon, 1946	0.6919	0.3712	0.0934	−0.1565	0.3775	0.3075	0.2200	0.0950
Homberg, 1949	0.7085	0.3911	0.0923	−0.1919	0.3911	0.3102	0.2064	0.0923
Beer & Resinger, 1954	0.7125	0.3900	0.0875	−0.1900	0.3960	0.3115	0.2045	0.0875
Hendry & Jaeger, 1955	0.7167	0.3825	0.0850	−0.1842	0.3825	0.3200	0.2125	0.0850
Engesser, 1889	0.7000	0.4000	0.1000	−0.2000	0.4000	0.3000	0.2000	0.1000

Note: The values of Hendry & Jaeger are identical with values of Leonhardt and Homberg for $z = \alpha/2$ (Eq. 5).

TABLE II. Ordinates of load distribution diagrams considering torsional grid resistance

Method	Girder A				Girder B			
	A	B	C	D	A	B	C	D
Massonnet, 1950	0.5350	0.3310	0.1465	−0.0115	0.3310	0.2900	0.2325	0.1465
Jager, 1953 Beer & Resinger, 1954	0.5285	0.3325	0.1525	−0.0135	0.3325	0.2900	0.2250	0.1525
Hendry & Jaeger, 1955	0.5431	0.3309	0.1451	−0.0191	0.3309	0.2970	0.2270	0.1451
By Eqs. 10, 11, 12	0.5282	0.3313	0.1521	−0.0116	0.3313	0.2894	0.2272	0.1521
By Eq. 9	0.5194	0.3398	0.1602	−0.0194	0.3398	0.2880	0.2200	0.1602

Note: For four equally spaced girders, $b/2 = 2a$ and $1/\vartheta^4$ (Eq. 4) $= z$ (Eq. 3). (a/l) in Eq. 7 has to be squared for use in Table II.

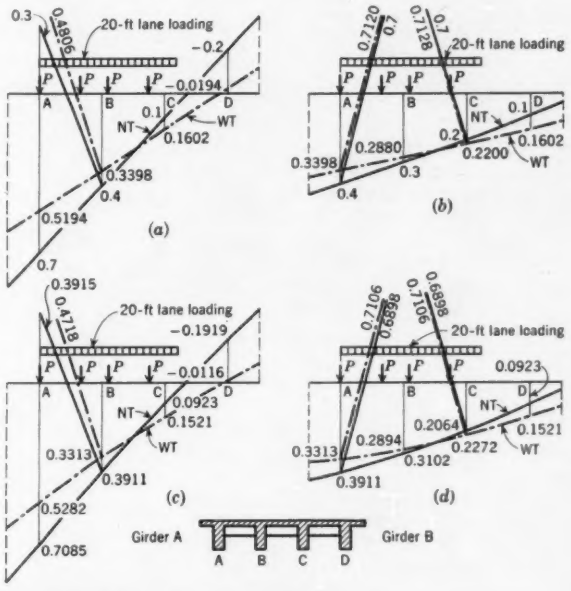


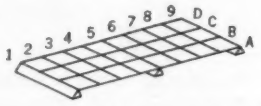
FIG. 2. Load distribution diagrams are for four-girder bridge framed by center diaphragm. NT = load distribution considering only flexural grid stiffness; WT = load distribution considering both flexural and torsional grid stiffness.

TABLE III. Design live loads and comparative live-load moment areas

Loading Case		$z = \infty$, $\tau = 13.41$, Fig. 2 (a) and (b)				$z = 73$, $\tau = 13.41$, Fig. 2 (c) and (d)			
		Load on Simple Beam, $U(l)$	Load on 2-Span Beam, $U(\lambda)$	Loading	Area of Moment Diagram	Load on Simple Beam, $U(l)$	Load on 2-Span Beam, $U(\lambda)$	Loading	Area of Moment Diagram
Girder A:									
Four unit loads	NT	1.755	−0.407	H 20-S 16–44	1.22	1.734	−0.391	H 20-S 16–44	1.21
	WT	1.452	−0.105	truck	1.05	1.434	−0.087	truck	1.04
20-ft lane load	NT	7.469	−2.909	H 20–44	1.41	7.643	−3.391	H 20–44	1.42
	WT	6.478	−1.885	lane	1.25	6.392	−1.799	lane	1.24
AASHO	SBR	1.347	.....	Truck	1.00	1.347	.....	Truck	1.00
	SBR	4.593	.....	Lane	1.00	4.593	.....	Lane	1.00
Girder B:									
Four unit loads	NT	1.251	0.571	H 20-S 16–44	0.75	1.245	0.560	H 20-S 16–44	0.75
	WT	1.151	0.672	truck	0.71	1.150	0.660	truck	0.71
20-ft lane load	NT	5.823	3.363	H 20–44	0.69	5.912	3.278	H 20–44	0.70
	WT	5.493	3.691	lane	0.66	5.553	3.604	lane	0.67
AASHO	S/5	1.834	.....	Truck	1.00	1.834	.....	Truck	1.00
	SBR	9.186	.....	Lane	1.00	9.186	.....	Lane	1.00

TABLE IV. Load distribution ordinates computed from measured deflections and by theory

	Load at A3				Load at B3			
	A3	B3	C3	D3	A3	B3	C3	D3
Measurements	0.4618	0.3058	0.1637	0.0687	0.3058	0.2916	0.2389	0.1637
Eqs. 10, 11, 12: t_e	= 0.4700	0.3052	0.1683	0.0565	0.3052	0.2876	0.2389	0.1683
Massonnet: t_m	= 0.4607	0.3074	0.1643	0.0675	0.3074	0.2927	0.2356	0.1643



	Load at A3 and B3				Load at B3 and B7				Load at A3, B3 and C7, D7			
	A3	B3	C3	D3	A3	B3	C3	D3	A3	B3	C3	D3
Measurements	0.3766	0.2966	0.1988	0.1280	0.3199	0.3098	0.2356	0.1347	0.4722	0.3284	0.1832	0.0162
$t_e + \Delta t$	0.3876	0.2964	0.2036	0.1124	0.3268	0.3023	0.2346	0.1363	0.4953	0.3327	0.1673	0.0047
					0.3236	0.3002	0.2352	0.1410	0.4795	0.3274	0.1726	0.0205
$t_m + \Delta t$	0.3840	0.3001	0.2000	0.1159	0.3299	0.3094	0.2299	0.1308	0.4890	0.3393	0.1608	0.0109
					0.3266	0.3069	0.2308	0.1357	0.4736	0.3335	0.1666	0.0263

$\Delta t = \frac{\delta_N}{\delta_L}, t = \frac{\delta_N}{\delta_L}$	Load at A7				Load at B7				Load at C7 and D7			
	A3	B3	C3	D3	A3	B3	C3	D3	A3	B3	C3	D3
0.3913 t_e −0.0978	0.0861	0.0216	−0.0320	−0.0757	0.0216	0.0147	−0.0043	−0.0320	0.1077	0.0363	−0.0363	−0.1077
0.3340 t_e −0.0835	0.0735	0.0184	−0.0273	−0.0646	0.0184	0.0126	−0.0037	−0.0273	0.0919	0.0310	−0.0310	−0.0919
0.3913 t_m −0.0978	0.0825	0.0225	−0.0335	−0.0715	0.0225	0.0167	−0.0057	−0.0335	0.1050	0.0392	−0.0392	−0.1050
0.3340 t_m −0.0835	0.0704	0.0192	−0.0268	−0.0610	0.0192	0.0142	−0.0048	−0.0286	0.0896	0.0334	−0.0334	−0.0896

δ_N denotes the deflection of the unloaded span, δ_L of the loaded span. $\delta_{N7}/\delta_{L3} = 0.3913$ is the theoretical value; 0.3340 was computed from a set of measured deflections.

20.0 (Eq. 8). Neglecting torsional grid stiffness, F. Leonhardt (1938) obtained the load-distribution ordinates for Girder A of, 0.812, 0.431, 0.123, − 0.128. For different stiffness of the outer and inner girders, Eq. 9 becomes:

$$t_1 \ldots t_n = \frac{\tau}{2 + (n-2)\tau} \pm \frac{3[n - (2i-1)]\tau}{(n-2)(n-3)\tau + 6(n-1) + \tau} \quad (13)$$

Introducing $n = 4$, $i = 1$ and the numerical values into Eq. 13, then

$$t_A \text{ and } t_D = \frac{\tau}{2 + 2\tau} \pm \frac{9\tau}{2\tau + 18 + \tau} = \frac{1.75}{5.50} \pm \frac{15.75}{41.50} = 0.3182 \pm 0.3795$$

The diagram is a straight line; therefore its ordinates are: 0.698, 0.445, 0.192, and − 0.061. Evaluation of both distribution diagrams for H 20–44 truck loading results in $U^{(i)}$ and $U^{(\lambda)}$ loads of 1.703 and − 0.507; and 1.705 and − 0.511. The AASHO specifies 1.195 wheel loads. Both distribution diagrams result in the same moment diagram area, which is 30 percent larger than that specified by the AASHO.

Grid models

Table IV lists ordinates for load-distribution diagrams computed from the average of sets of deflections measured by P. B. Morice and G. Little on a prestressed-concrete bridge grid specimen. The two-span continuous four-girder grid had three equally spaced diaphragms in each span, and $l = 80$, $\lambda = 20$, $a = 9.75$, $\vartheta = 0.387$ (Eq. 4), $1/\vartheta^4 = z = 44.58$ (Eq. 3), $\alpha = 0.438$ (Eq. 6), $I_x = 10.667$, $I'_g = 7.33$, $I_c = 3.467$, $I'_c = 4.04$, $G = 0.5\ E$. Not considering the torsional stiffness of the diaphragms, $\tau = 23.72$ (Eq. 8). Ordinates computed by Eqs. 10, 11 and 12, and by the Massonnet method as published, are also listed in Table IV.

The ordinates for "Load at A3 and B3" are the averages of the ordinates of "Load at A3" and "Load at B3." When both spans are loaded, "Load at B3 and B7" and "Load at A3, B3 and C7, D7," the Δt values make the ordinates to fit the behavior of this grid. This means that, for any position of the load, the deflections of the four girders of the unloaded span were the same and invariably equal to the measured mean deflection. The addition of Δt to t_e and t_m results in ordinates that are very consistent with those derived from the measured deflections.

The continuity of the grid girders can be considered by reducing z in the ratio of the continuous and simple beam deflections: $z = 0.7188(44.58) = 32.04$. The torsional stiffness remains unchanged: $\tau = 23.72$. Load at A3, $t_e = 0.4752, 0.3002, 0.1636, 0.0610$. Load at B3, $t_e = 0.3002, 0.2930, 0.2432, 0.1636$. Load at A3 and B3, $t_e = 0.3877, 0.2966, 0.2034, 0.1123$. These values are practically identical with those listed in Table IV.

For the outer and inner girders of a bridge with two 80-ft spans and H 20-S 16–44 truck loading, the AASHO specifications require areas for the design live-load moment diagram that are 1.5 percent and 33.2 percent larger, respectively, than can occur in a properly designed grid of the properties of this model.

J. Schöttgen (1947) investigated a reinforced concrete four-girder grid model (1:15) with a center diaphragm, of the following dimensions: $l = 59.05$ ft, $a = 8.2$ ft, $I_g = 1.0$, $I_c = 0.619$, $I'_g = 0.505$, $G = 0.397\ E$, $\tau = 9.35$ (Eq. 8). The measured ordinates for the load-distribution diagram of Girder A were: 0.541, 0.328, 0.140, and −0.009. Those computed by the use of Eq. 9 are: 0.557 0.352, 0.147, and −0.056. The area of the moment diagram due to H 20–44 truck loading based on the latter ordinates is 4 percent larger than that derived from the measurements, whereas the AASHO specified area is 9 percent smaller.

Continuous prestressed concrete bridge

A four-girder bridge 918.63 ft long, with seven continuous spans, was built at Northeim, Germany, in 1955. In it, $l = 131.23$ ft. There are three equally spaced diaphragms, and the girder spacing is 9.84, 11.02, 9.84 ft (1 : 1.12 : 1). $I_A = 1.132$; $I_B = 1.0$; $\Sigma(I'_g/I_g) = 0.269$; $G/E = 0.5$. Assuming a rigid center diaphragm, then

$$t_1 \ldots t_n = I_{gi}\left[\frac{1}{\Sigma I_g} \pm \frac{x_i e}{\Sigma I_g x^2} \times \bar{\tau}\right] \quad (14)$$

(Engesser 1892)

$$\text{where } \bar{\tau} = 1/(1 + \frac{1}{12}\frac{G}{E}\sum \frac{I'_g}{I_g}\frac{l^2}{\Sigma x^2}) \quad (15)$$

(Schöttgen 1947)

$\Sigma I_g = 2(1.132 + 1) = 4.264$; $\Sigma I_g x^2 = 2(0.56^2 + 1.56^2 \times 1.132) = 6.1369$; $\Sigma x^2 = 5.4944$; $l^2/\Sigma x^2 = 32.356$; $\bar{\tau} = 0.7336$ (Eq. 15).

For Girder A: $x_A e = 1.56^2 = 2.4336$.

TABLE V. Load distribution behavior of long-span steel box-girder bridges

Bridge Location	Girder Length ft	Span Length ft	Girder Spacing ft	Girder A				Girder B			
				A	B	C	D	A	B	C	D
Köln-Deutz, 1948	1,434.75	605.15	12.64*	0.2714	0.2517	0.2401	0.2368	0.2517	0.2561	0.2521	0.2401
Düsseldorf-Neuss, 1951	1,351.70	675.85	23.07*	0.2858	0.2558	0.2330	0.2293	0.2519	0.2608	0.2543	0.2330
Smidt, Bremen, 1952	724.40	367.50	23.35	0.3196	0.2514	0.2162	0.2128	0.2514	0.2726	0.2598	0.2162

	Köln-Deutz			Düsseldorf-Neuss			Smidt, Bremen		
	Design Moment Area Ratio		Total Moment Area	Design Moment Area Ratio		Total Moment Area	Design Moment Area Ratio		Total Moment Area
	A	B		A	B		A	B	
Eqs. 10, 11, 12	1	1.04	0.96	1	1.02	0.95	1	1.04	1.00
AASHO Specifications	1	1.53	1.00	1	1.46	1.00	1	1.81	1.00

* Average spacing; actual is 11.97, 13.98, 11.97 and 24.61, 20.01, 24.61 ft.
Note: Roadway width is taken as center to center of Girders A and D. Live load, H 20–44.

t_A and t_D =

$$\left[\frac{1.132}{4.264} \pm \frac{2.7548}{6.1369} \times 0.7336\right] =$$

$0.2655 \pm 0.3293 = 0.5948$ and -0.0638

For Girder B:

$x_B e = 0.56 \times 1.56 = 0.8736$

t_A and t_B =

$$\left[\frac{1}{4.264} \pm \frac{0.8736}{6.1369} \times 0.7336\right] =$$

$0.2345 \pm 0.1044 = 0.3389$ and 0.1301

The distribution diagrams are straight lines; therefore the ordinates are as follows:

For Girder A: 0.5948, 0.3837, 0.1474, −0.0638

For Girder B: 0.3389, 0.2720, 0.1970, 0.1301

These values are identical with those published. The evaluation of these diagrams for H 20-S 16–44 truck loading results in a 28.6-percent larger, and a 29.1-percent smaller, moment-diagram area for the outer and inner girders respectively, than required by the AASHO specifications. The ratio of these areas is 1.2 : 1, whereas the ratio of the specified areas is 1 : 1.5. These reversed values are specified for any stiffness ratio of the girders.

Continuous long-span plate girder bridges

Measurements on long-span, continuous plate-girder bridges with monolithic steel floors revealed uniform distribution of the live load among the girders. Table V contains load-distribution-diagram ordinates, computed by the use of Eqs. 10, 11 and 12, for three four-girder bridges.

The design live-load distribution requirements of the AASHO specifications increasingly deviate from reality with increasing span length and increasing torsional stiffness of the bridge. Measurements of the center span (643.04 ft long) of the 3-span continuous Bonn-Beuel Bridge, 1,292.64 ft long, built in 1949, indicated uniform distribution of eccentric loads among the four girders framed by a floor of buckle plates filled with thoroughly anchored concrete and cross frames spaced at 23 ft.

Composite girder bridges with heavy anchored slabs

The distribution of the live load becomes less uniform with decreasing span length for the same I and I_t ratios. Nevertheless, the behavior of composite girder bridges with heavy anchored slabs may substantially deviate from the AASHO specification requirements, especially if the torsional rigidity of the structure is assured. This is true even in the short-span range, especially if there are girders under sidewalks.

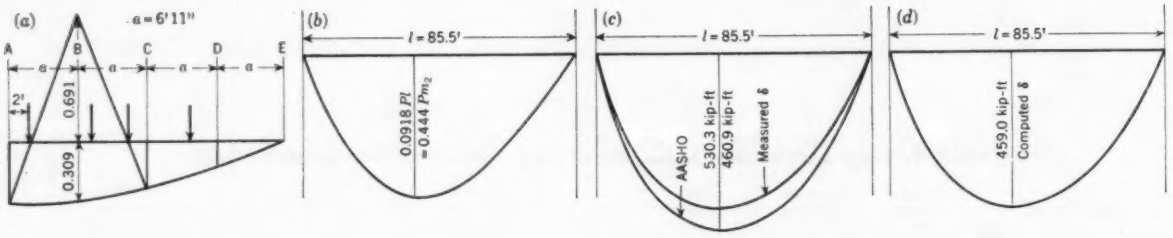
In 1949, a 290,000-lb loading was applied on a seven-girder bridge of 59.71-ft span in which only three girders are under the 36-ft roadway. The girders are framed by a center diaphragm and by entering the top flanges into the 8.7-in.-thick slab. The measured deflections were not only smaller than those computed by the assumption of an infinitely rigid diaphragm, and $E_s/E_c = 6$, but the shape of the diagram, of 17-percent smaller area, disclosed also the effect of the torsional rigidity of the composite structure. Table VI shows the measured distribution of H-20 truck loading among the girders, and as required by the AASHO design specifications.

Slab-framed I-beam bridges

If the simultaneous deflections of the framed girders along the diaphragm or transverse section, due to a load on the girders, are known, the load-distribution properties of the framing can be derived as outlined in the foregoing. This procedure applies also to slab-framed I-beam bridges, like the five-girder continuous bridge at Xenia, Ohio. This structure has two 85.5-ft spans. Its measured deflections were published in 1945. Evaluation of measured deflections due

TABLE VI. Measured and AASHO load distribution

Method	Moment Area of Girder			Total Area
	A & G	B & F	C, D, E	
Measured, kip-ft²	8,420	10,630	13,470	78,510
AASHO, kip-ft²	0.000	7,280	22,920	83,320
Difference	100%	32%	41%	5.77%



Load distribution from measured deflections

Loading	$U^{(i)}$	$U^{(\lambda)}$
Unit load	0.309	0.691
Four-unit load, H 20	1.036	0.362

Load distribution from computed deflections

Loading	$U^{(i)}$	$U^{(\lambda)}$
Unit load	0.319	0.681
Four-unit load, H 20	1.043	0.355

Moments due to a moving unit load

	m	U	mU
2 *	0.2064	0.309	0.0638
4 †	0.0491	0.691	0.0339
	$P = 0.473$		$M = 0.0977$
2 *	0.2072	0.309	0.0640
6 †	0.0411	0.691	0.0284
	$P = 0.446$		$M = 0.0924$
2 *	0.2064	0.309	0.0638
8 †	0.0405	0.691	0.0280
	$P = 0.444$		$M = 0.0918$

Positive moments due to H 20–44 truck loading

	m	U	mU
2 *	0.1729	1.036	0.1791
4 †	0.0999	0.362	0.0362
			$M = 0.2153$

$k = 1.202$, or 13.1% less than AASHO k, which $= S/5 = 1.383$.

Positive moments due to H 20–44 truck loading

	m	U	mU
2 *	0.1729	1.043	0.1803
4 †	0.0999	0.355	0.0355
			$M = 0.2158$

$k = 1.197$, or 13.4% less than AASHO k, which $= S/5 = 1.383$.

* Number of actual spans. † Number of imaginary spans

FIG. 3. Moments derived from measured and computed deflections of Xenia Bridge

to load on Beam B is shown in Fig. 3.

Useful results can be obtained also by evaluating, for H-20 loading, the distribution diagrams of the perfectly rigid diaphragm of Beam B in Fig. 1(*d*), as follows: $U^{(i)} = 1.022$, $U^{(\lambda)} = 0.376$, resulting in $k = 1.213$, which is less than 1 percent larger than the value obtained from the measured deflections.

Torsionally rigid, two-girder bridge

The torsionally rigid two-girder bridge cannot be designed satisfactorily by the AASHO specifications, which require simple-beam distribution. The two-girder prestressed concrete Laiblach River Bridge framed by the slab only, built in 1951 in Lindau, Germany, proves this. Here $l = 90.55$ ft, $a = 17.39$ ft, $I_g = 17$ ft^4, $I'_g = 10.08$ ft^4, $I_c = 0.0795$ ft^4/ft, I'_c (for $\frac{4}{3}a$) $= 7.18$ ft^4, (for $2a$) $= 10.86$ ft^4, $\tau_{4a/3} = 8.96$, $\tau_{2a} = 10.87$.

The value of τ depends on the torsionally effective slab length. For a concentrated load, the 1.9 a length results from the slab theory. The assumption of a sine curve for Girder B defines the moment influence diagram. Equation 9 yields the mid-span ordinate, 6.78. The others are 6.78 sin $(x/l)\ \pi$. Deducting these from the simple-beam ordinates, the influence line of Girder A is obtained. For the torsionally effective slab length of $4a/3$ used, the resulting girder moments are identical with those derived by W. Klemp, based on J. C. de F. Ferraz's theory. For the H 20-S 16–44 truck loading, the mid-span moment is 21.3 percent smaller than required by the AASHO specifications.

Computing girder moments

In computing the girder moments, the grid is assumed to be composed of two superimposed systems: (1) the girders as actually supported, and (2) as assumed to be supported, also at the location of the diaphragms. The $U^{(i)}$ load, obtained from the t_d distribution diagram, acts on the actual beam, and the $U^{(\lambda)}$ load, obtained from the $(1 - t_d)$ diagram, acts on the imaginary beam. The actual girder moment is the sum of these two moments. This procedure gives rigorously correct moments only for simple-span girders with a center diaphragm. The deviations in other cases are within design accuracy.

Rather than extend his method to the use of higher harmonics, Guyon proved in 1946 that for low values of ϑ (Eq. 4) the first harmonic can be used in computing moments. This means neglecting the effect of the $U^{(\lambda)}$ loads. Furthermore, he stated that for ϑ (Eq. 4) values between 0.4 and 0.7, it is sufficient to increase the bending moment based on the first harmonic by about 15 percent. P. B. Morice and G. Little verified the safety of these recommendations experimentally.

The data in Table III reveal that for $z = 73$ and $\tau = 13.41$, the $U^{(\lambda)}$ loads change the moments of the $U^{(i)}$ loads by the following percentages: in Girder A: −8, −3, −24, −15; in Girder B: +7, +8, +6, +6. The ϑ (Eq. 4) value in this example is smaller than 0.4.

The first harmonic bending-moment coefficients computed by the method of Hendry and Jaeger in Table VII result in a moment of 1517.8 kip-ft, which is only 2.13 percent smaller than the moment obtained by the method of Klemp and by the presented approximate method for $4a/3$ torsionally effective slab length.

When there are more than two diaphragms in a span, the $U^{(\lambda)}$ load can be assumed to act on a simple beam of span length λ. This procedure, recommended by H. Homberg in 1954, is quick and it is always on the safe side. In the example in Table IV there are three diaphragms per span. The simple λ span moment in this case results in a 4-percent larger design moment than the six-span beam moment. With increasing number of diaphragms, this percentage diminishes, justifying the simple λ span consideration of the effect of the $U^{(\lambda)}$ load.

Diaphragm stresses

Grid action is assured if the sections and connections of the load-distributing

cross-framing satisfy the requirements of continuity under all loading conditions. Diaphragm moment and shear influence lines can be computed by the use of the load-distribution diagrams.

A. G. Tadros and A. Ghali (1955) made measurements on a three-girder grid model with three equally spaced diaphragms, where $l = 60$, $a = 12$, $\lambda = 15$, $I_o/I_c = 3.59/1.6$, $z = 6.96$ (Eq. 3). The ordinates of the load-distribution diagram are:

$$\text{Girder A, } t_A = \frac{1 + 1.25\,z}{1 + 1.5\,z} \quad \ldots\ldots (16)$$

$$\left.\begin{matrix}\text{Girder A, } t_B \\ \text{Girder B, } t_A \text{ and } t_C\end{matrix}\right\} = \frac{0.5\,z}{1 + 1.5\,z} \quad (17)$$

Considering that the sum of the ordinates of a load-distribution diagram equals unity, their numerical values become:

For Girder A: 0.8479, 0.3042, − 0.1521
For Girder B: 0.3042, 0.3916, 0.3042

Using these values, the following ordinates of the moment influence line of the center section of the center diaphragm result:

At Girders A and C: $(0.8479 - 1)12 = -1.825$

At Girder B: $(0.3042)12 = 3.650$

The loading of this influence line is obtained from the "floor beam reaction" influence line, the area of which is 1.25λ in this case. Therefore, the diaphragm moment $M_c = 17.19(3.650 - 1.850) = 31.36$. The published moments are 31 and 24.25 for the center and the two outer diaphragms respectively.

Comparatively flexible but properly connected diaphragms are efficient load distributors between closely spaced beams, that is when $a < 0.1\,l$, the design of such diaphragms may be governed by shear. The behavior of models will illustrate conditions.

The model of a three-span continuous, seven-girder bridge 787.4 ft long (Schaechterle 1939), where $a = 0.044\,l$, and the moment of inertia of one floor beam was only about 1/250th of that of the girders, showed that one of these small floor beams at midspan of the 328.1-ft center span resulted in load-distribution ordinates under the loads which were on the average 33 percent larger than those resulting from all 21 floor beams in this span. Five floor beams spaced in 0.18 of the length of this span at midspan, however, produced nearly the same load-distributing effects as 21 floor beams in the full length of the span.

The model of a seven girder bridge 997 ft long with seven cantilever spans (Sattler 1939), where $a = 0.078\,l$, disclosed that one cross beam at midspan of a 157.5-ft span, having a moment of inertia of 1/14 of that of the girders, resulted in load-distribution ordinates under the girders which were on the average 23 percent larger than those resulting from three equally spaced cross beams of the same section. The latter distribute H 20-S truck loading between the girders so that the moment areas are nearly the same. The AASHO specifies a 61-percent larger moment area for the inner girders than for the outers in this case.

The model of a 125-ft-span, five-girder bridge with four equally spaced diaphragms (Leonhardt 1940), where $a = 0.129\,l$ $I_A/I_B = 1.2$, and $I_c/I_B = 0.21$, or the diaphragms have a moment of inertia 1/4.76 of that of the inner girders, revealed that the measured diaphragm stresses due to uniform loading were 28 percent smaller than computed by the use of load-distribution ordinates corresponding to a center diaphragm of $1.6\,I_c/I_B$ ratio.

Generally the stresses in the girders remain nearly the same regardless of the number of load distributing diaphragms of the proper design greater than three. With increasing a/l ratio, the stiffness of the diaphragm gains in importance. The required diaphragm sections can be approximated satisfactorily by the use of the load-distribution diagrams with due empirical consideration of the actual characteristics of the grid framing. In spans of great torsional stiffness load-distribution occurs without the provision of any intermediate diaphragms.

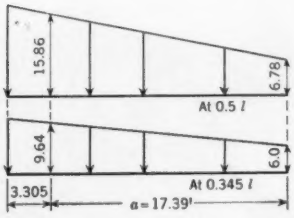
Conclusions

The simple procedures that have been presented here for the computation of the grid action of bridges give satisfactory results for design purposes. This is shown by examples of simple and continuous bridges of concrete and steel. The AASHO load-distribution specifications are arbitrary in that they disregard the geometric and rigidity properties of bridges, by the proper selection of which, structural and economic advantages and good appearance can be achieved.

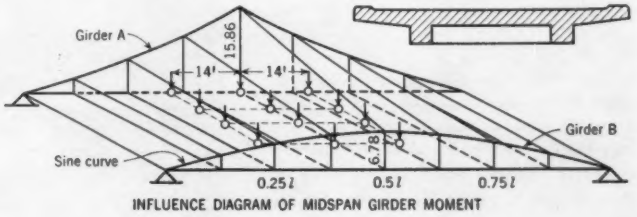
TABLE VII. Load distribution in prestressed-concrete two-girder bridge framed by slab only

Method	Girder A	Girder B
Klemp	0.7014	0.2986
Eq. 9 ($\tau_{4a/3}$)	0.7005	0.2995
Eq. 9 (τ_{2a})	0.6778	0.3222
Hendry & Jaeger	0.6628	0.3374

Method	Influence-Line Ordinates of Midspan Girder Moment							
	0.5 l		0.375 l		0.25 l		0.125 l	
	A	B	A	B	A	B	A	B
Klemp	15.88	6.76	10.81	6.17	6.66	4.66	3.20	2.46
Eq. 9 ($\tau_{4a/3}$)	15.86	6.78	10.72	6.26	6.53	4.79	3.07	2.59



Actual $M = 53.63 \times 16\frac{1}{2} + 34.63(16 + 4) = 1550.7$
AASHO = 1970.9



INFLUENCE DIAGRAM OF MIDSPAN GIRDER MOMENT

Navigation, flood control, power — TVA develops its rivers

REED A. ELLIOT, M. ASCE, Chief Water Control Planning Engineer, Tennessee Valley Authority, Knoxville, Tenn.

The Tennessee River has both invited and challenged civil engineers for generations. Early in the history of hydroelectric power, the eastern region of high rainfall and favorable dam sites invited development. Then too, the valley-wide record of devastating floods, and at times severe drought, challenged the early efforts to improve its usefulness for navigation. Inherently it has been a tough customer to handle with anything short of a major effort. Even now, as one of the most highly developed rivers in the world, it still must command the full respect of those who make use of its potential.

Fortunately, the Tennessee is also a good river to work with in many of its characteristics. Thus it was susceptible to economically sound development of a nature that represents a major contribution to the national wealth. As the fourth largest river in the United States in terms of flow, its development ranks high on the list of engineering effort and accomplishment.

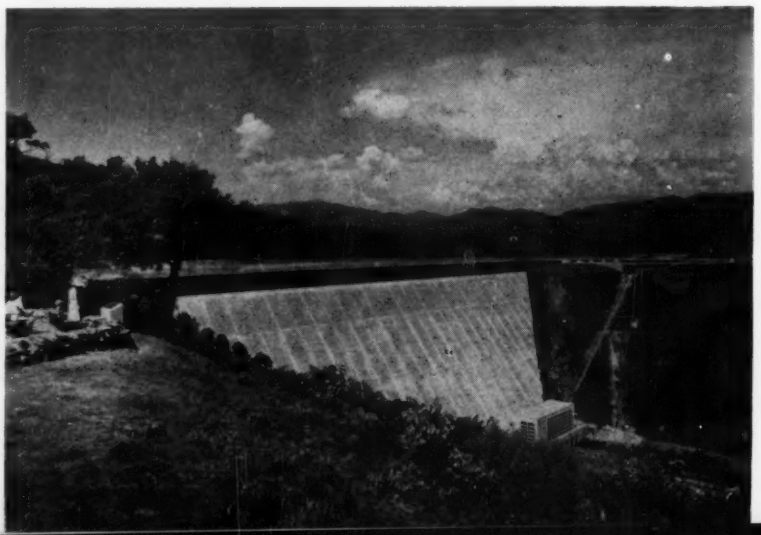
Twenty years ago TVA placed in operation the first tributary multiple-purpose project of the Tennessee River water-control system. This was the now widely-known Norris project. Later in the same year, the Wheeler project was put into initial use. These two widely separated projects typify the functions of the integrated system of today. Norris Reservoir provided storage capacity for seasonal regulation of stream flow. Wheeler Reservoir and navigation facilities created a 74-mile link in the inland waterway system. Both projects included power generating facilities. Together with the existing Wilson Dam at Muscle Shoals, Ala., and the Hales Bar Dam near Chattanooga, Tenn., they represented a substantial beginning toward the full development of the Tennessee River system.

Less than 10 years later, in 1945, two other similar and again widely separated projects were brought into use. Fontana project, created by a dam 480 ft in height, provided regulation and power generation on the Little Tennessee in the North Carolina mountains. Kentucky, with its reservoir capacity of 6 million acre-ft, located near the mouth of the Tennessee, created additional flood regulation for the lower Ohio and Mississippi Rivers, a navigable channel 185 miles in length, and offered an ultimate power installation of 160,000 kw.

During the intervening years, five projects were completed on the main stem of the Tennessee and seven on tributary streams in the eastern valley. Following 1945, four additional hydro plants were constructed on the Holston River. This year, at the Hiwassee plant, the last vacant stall in existing hydro stations has been filled with the completion of a pump-turbine installation, a single-shaft reversible unit.

Along the main river from Knoxville to the Ohio River, 9 reservoirs create a 650-mile navigable waterway having a total lift of 510 ft. On the tributaries, 19 plants furnish effective regulation and develop a large part of the potential head. Together they provide about 12 million acre-ft of flood storage capacity and a power installation of nearly 2,750,000 kw. With the 375,000 kw installed at Alcoa plants, the total hydro capacity in the valley is now over 3 million kw.

The character of the river and its watershed largely determine the potential for multiple-purpose development of its water resources. Here we are dealing with a territory of 41,000 sq miles including parts of seven states. The topography varies from the rugged



Fontana Dam is seen from visitors' parking area, looking upstream. This dam on Little Tennessee River, in North Carolina, has maximum height of 480 ft, providing total reservoir volume of 1,445,000 acre-ft. Total capacity of three generating units is 202,500 kw.

Appalachian Mountains with peaks above 6,000 ft, to the flat expanses of north Alabama, Mississippi, and west Tennessee.

From Knoxville to Chattanooga, the main river falls 180 ft following a southwesterly course of about 180 miles. From Chattanooga downstream, the Tennessee flows to the west through north Alabama and northwest Mississippi for 270 miles, and then sweeps north across Tennessee and western Kentucky 200 miles to the Ohio River at Paducah. This lower river falls some 330 ft. The fall is gradual except at Muscle Shoals, Alabama, where a drop of 100 ft is found in a stretch of less than 20 miles. The Elk and Duck Rivers and many smaller tributaries of the lower river increase the drainage basin to 41,000 sq miles at the mouth.

The Tennessee was an important artery of travel in the pioneer settlements, and efforts to improve navigation began more than 100 years before the TVA Act became law in 1933. In 1828 the Congress allotted land to the State of Alabama, the sale of which was to provide funds for a canal around Muscle Shoals. Many other efforts were made over the years toward dependable navigation, but these piecemeal attempts could not cope with the floods and droughts. Hales Bar Dam just downstream from Chattanooga, started in 1905, and the early projects built by the Aluminum Company of America on the Little Tennessee, starting in 1914, represented major developments. However, the most significant early step toward the multiple-use development of the water resources of the valley was the construction of Wilson Dam at Muscle Shoals during and following World War I.

Influences that shaped the TVA

The passage of the TVA Act in 1933 was the culmination of decades of public interest and engineering investigations concerned with the conservation and best use of the potential natural resources. Much of the engineering study was conducted by the Corps of Engineers and reported in a comprehensive manner in 1930 in the "308 Report." The TVA law reflects the long years of consideration in that it was specifically designed to fit the needs of the valley, and it thus furnishes the prime influence on the nature and scope of the TVA system.

The unique significance of the law lies in the adoption of the whole drainage area of the river as the unit of development, coupled with the requirement that development of the river shall be for three basic purposes—navigation, flood control, and power. Provisions of the Act have been interpreted most literally in the development of the water control system. In effect, they have been built into the structures and into the methods of operation, starting with the selection of dam sites and following through in the day-to-day operation. This is not a statement of opinion, but a matter of fact which is evident in the existing structures and can be clearly seen in the record of reservoir operation over a period of 20 years.

Probably the nature of the river itself and the law comprise the most obvious influences on TVA. Many other influences have been exerted over the years. Depression, litigation, aluminum for the defense program and later for war, atomic bombs—all have had their effect. But the human elements involving personnel, attitudes, and organization were highly important, as always, in getting the job done.

The TVA was started during a period of recovery from a devastating economic depression, when the top talents of our country were being only partly utilized in their accustomed places. The challenge of developing the fullest use of a river valley attracted outstanding engineers of broad and diverse experience from all sections of this country. Together, they made a notable organization.

A significant step was the decision to carry out the bulk of the construction by force account. This led to the creation of a closely knit planning, design, and construction organization and a carefully planned construction program designed for continuous use of skilled manpower and equipment.

From the beginning, the planning job was loaded with challenges and opportunities. Two conditions stand out. First, TVA had by law been assigned a program that was unique for its breadth. Comprehensive responsibility had been placed in one agency for a number of traditionally separate objectives. Second, with respect to the development of water resources, the Tennessee Valley was not too far removed from virgin status, and the threat of floods had kept the flood plains of the Tennessee River largely free of development in the form of major communities, highways, and railroads. Thus the broad assignment opened a wide field for investigation and decision and at the same time pinpointed responsibility for results.

The decision to build multiple-purpose dams appears most logical today when viewed in the light of present knowledge and against a background of successful operating experience. It was not so evident 20 years ago. At that time, and to a lesser extent since, it has been strenuously argued that flood control and power production with joint use of reservoir capacity are wholly incompatible.

Earlier multiple-use projects had combined power and flood control by providing entirely separate layers of reservoir capacity for each function. The TVA system, on the other hand, was planned and has been successfully operated to make joint use of a major part of each reservoir. In view of the fact that dam and reservoir sites must have physical or economic limitations, joint use is significant in realizing the fullest development. A completely independent reservation of flood control

A key reservoir for regulation of Ohio and Mississippi River floods is that of Kentucky Project, near mouth of Tennessee River in Kentucky. Controlled storage capacity is 4 million acre-ft.

Navigation will be improved at Wilson Dam in Alabama when large lock sketched in foreground, and now under construction, is completed. Single lift of 100 ft will be provided by lock chamber 110 × 600 ft.

storage usually would either limit the power potential of each site or would be obtained by pushing site development beyond economic limits. Thus the combined use of reservoir volume is an important element in the favorable relation of costs and benefits in the TVA system.

The outstanding characteristic of the valley, which made such system planning possible, is the seasonal distribution of basin-wide storms and the resulting floods of major proportions. Such floods are confined to the winter and early spring months—December to April—as a result of a combination of topographic, geologic, and weather conditions peculiar to the region.

The average rainfall in the basin in a year is about 51 in. and varies generally from 37 to 63 in. Along the mountainous southeastern valley rim, the annual average may reach 85 in. for small areas. For the basin as a whole, about 20 in., or 40 percent, falls during the flood season. Of this 20 in., something like 13 in. runs off. During the whole year, the total runoff is only 22 or 23 in., so that nearly half the yearly total occurs in the December-to-April flood period. Ground and weather conditions in the winter may result in runoff during a heavy storm of 75 percent or more of the rainfall. Under such circumstances major floods occur.

Heavy rains, in even greater amounts than during the major flood season in winter and spring, do occur over limited areas in summer and fall. These may result from tropical hurricanes or may be so-called local cloudbursts. They cause serious flooding only on tributary streams or small sections of larger streams.

Navigation with high lifts

With the emphasis on navigation, a fundamental choice had to be made between a system of numerous, low navigation dams and a smaller number of higher, multiple-purpose projects. Low dams would provide only navigation. The sailing line would follow the original channel. As many as 32 separate lockages would be required. Operation and maintenance costs of navigation facilities would be high. The power potential of the undeveloped stream could not be developed economically and would be permanently forfeited. (This potential for the seven TVA-built main-river plants is represented in the existing system by over 1 million kw of capacity and an estimated annual average of 6⅔ billion kwhr.) Finally, a navigation-only plan would provide no reservoir capacity for flood control.

Detailed studies of costs and benefits for several low-dam and high-dam schemes revealed that a system of high, multiple-use projects on the main stream offered the most economical solution and much superior facilities for water control. The decision in favor of this type of development of the main stem made possible a fully effective system of projects for flood regulation in the Tennessee River, together with material contributions to the reduction of flood stages on the Ohio and Mississippi.

The navigable channel is created by nine main-river reservoirs. They form a gently sloping stairway having nine risers of varying height from 40 to 100 ft and extending 650 miles from the Ohio River to Knoxville, a total lift of 510 ft. At the Ohio, the system is linked with nearly 10,000 miles of inland waterways connecting 20 of the 48 states.

The single-lift navigation locks at Kentucky and Pickwick Dams have 110- by 600-ft chambers. At the five other TVA-built dams, the lock chambers are 60 by 360 ft. The old Hales Bar Lock is 60 by 265 ft. Wilson Dam presents a different picture, having three separate locks, two in tandem at the dam and one downstream with a connecting canal 2½ miles long. These obsolete facilities now present a traffic bottleneck which will be eliminated by the proposed construction of a single 110- by 600-ft lock with a 100-ft lift. Construction of this lock and related channel improvements was started in July 1956.

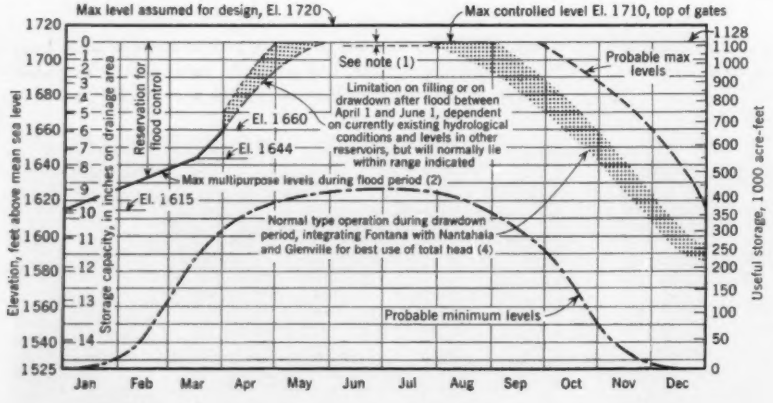
Flood control, a four-pronged effort

Regulation of floods by the TVA system can be considered as a four-pronged effort: (1) acceleration of flood-threatening flows through the system, (2) impounding of the bulk of the contributing flow from tributary streams, (3) flattening of flood crests by impoundage at projects close to the point of flood hazard; and (4) gradual release of stored water following the flood crest to regain storage capacity. The first of these functions is accomplished largely by the chain of main-stem projects, the second by tributary projects with substantial reservoir capacity, and the third by both tributary and main-river storage.

Flood control storage capacity is provided by a seasonal schedule for reservoir levels at all multiple-use projects. A total of at least 11,800,000 acre-ft is available on January 1 of each year. This amount may be reduced as the flood season progresses to 10,400,000 acre-ft on March 15. A total of nearly 2,500,000 acre-ft is held available for flood operations during the summer months. See Fig. 1 for a typical seasonal schedule for multiple-purpose operation of the Fontana Project.

Reduction of flood heights is afforded to lands and communities below the dams on the Tennessee River and parts of the tributaries. Benefits are also felt on the lower Ohio and Mississippi Rivers. Within the Valley, the city of Chattanooga, located at the pinched-in

FIG. 1. Typical seasonal schedule for multiple-purpose reservoir operation of Fontana Project is shown by graph.


Max level assumed for design, El. 1720
Max controlled level El. 1710, top of gates
See note (1)
Probable max levels
Limitation on filling or on drawdown after flood between April 1 and June 1, dependent on currently existing hydrological conditions and levels in other reservoirs, but will normally lie within range indicated
El. 1660
El. 1644
El. 1615
Max multipurpose levels during flood period (2)
Normal type operation during drawdown period, integrating Fontana with Nantahala and Glenville for best use of total head (4)
Probable minimum levels
Reservation for flood control
Storage capacity, in inches on drainage area
Elevation, feet above mean sea level
Useful storage, 1000 acre-feet
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Notes:

(1) Reservoir would normally be drawn down 2 ft or more through turbines to provide storage space for control of runoff from freshets.

(2) To be exceeded only during flood control operations.

(3) Based upon drainage area at Fontana Dam less drainage areas at Glenville and Nantahala Dams [1571 − (36.7 + 91.0) = 1443.3 sq miles].

(4) Best use of the head would normally be achieved by delaying drawdown at Fontana until Glenville and Nantahala Reservoirs have been lowered to approximately 50 percent useful content by September 1 or shortly thereafter.

midpoint of the watershed, is the most vulnerable locality. A repetition of the greatest known flood (1867) without control would cause damage in this area estimated at $105,000,000 on the basis of present-day development. Regulation by the TVA system is capable of reducing damage in such a flood to the level of about $12,500,000. Greater floods than that of 1867 are, of course, possible. The operation of tributary projects and main-river projects upstream from Chattanooga is necessarily keyed to protection of that area and now provides a degree of regulation which makes the further protection of Chattanooga by levees feasible.

Downstream from Chattanooga, the main-stream reservoirs provide about 5,000,000 acre-ft of storage capacity for flood regulation. The bulk of this capacity is in the great Kentucky Reservoir. With the dam located only 20 miles above the mouth of the Tennessee River, this storage is particularly effective as a contribution to the regulation of flood stages in the lower Ohio and Mississippi Rivers.

Power potential developed

Power generating facilities were planned to develop adequately the potential at each site. All projects were built with initial installations and in most cases with provision for additional units. All spare stalls have since been filled. Of the 29 hydro projects in the TVA system, 20 were built by TVA forces and the remainder were acquired.

Hydro power facilities of the TVA system include 118 generating units having a total rated capacity of about 2,750,000 kw and a potential average annual output estimated at nearly 14 billion kwhr. The individual installations at major hydro plants range from 436,000 kw at Wilson Dam to 10,000 kw at the Chatuge project. The most recent and most unusual addition to the hydro system is the recently installed pump-turbine at the Hiwassee project. As a turbine-generator, this unit is rated at 59,500 kw at normal head. As a motor-pump, it takes an input equivalent to 102,000 hp when pumping at a rate of 3,900 cfs.

These facilities are operated as an integrated system together with the hydro plants of the Aluminum Co. of America on the Little Tennessee, the plants built by the Corps of Engineers on the Cumberland River, and TVA's steam-electric plants.

Ten projects were initiated during the prewar emergency and during the war. In this period, new construction records were established. For example, dam closure was made at the 35-million-dollar Douglas project 13 months after the start of construction. Following the war, four major hydro projects were completed, and generating units were installed to fill all the powerhouse stalls provided in the initial construction of the projects.

The first ten years of construction activity experienced gradually rising costs, with the most rapid jumps during the war years. Further increases were of course experienced during the last decade. However, the bulk of the investment in water control projects was made at most favorable cost levels.

Acting under the law creating the TVA, the Board of Directors has, with requests to Congress for the first appropriation to start a new project, submitted a project report describing the scope of the proposal and presenting an estimate of cost. The total estimated cost submitted to Congress for construction of 20 hydro projects from 1933 to 1954 was $621,721,000. The actual cost was $637,889,000, within 2.6 percent of the estimated cost. For individual projects there were of course greater variations, particularly during war years.

Method of cost allocation

The allocation of the TVA investment in multiple-use projects to navigation, flood control, and power has drawn varied reactions. It has been held up as a model by some and by others has been severely questioned. It has been said that not enough has been charged to power, and also that navigation and flood control costs were artificially low because of the large allocation to power. Any allocation involving joint costs is, by its very nature, not subject to an absolute determination. Some degree of judgment is inevitably involved. However, it is my firm conviction that TVA's allocation is based on a method as reasonable and realistic as highly qualified and objective men can devise.

Basically, the method is one of allocating common or joint costs after direct, or separable, costs have been identified. Direct costs are found in terms of the cost incurred by the presence of each function in the system of projects. Thus they represent more than simply the cost of power generating facilities in the case of power, or of the lock in the case of navigation. The remaining common costs are apportioned on the basis of alternative justifiable costs for each function, as adjusted by deducting the amount of the direct costs.

This method, described as the Alternative Justifiable Expenditure Theory, was first applied by TVA in 1937. It was reviewed and approved by a Congressional Investigating Committee in 1938. More recently, in 1949, it was reviewed in detail by the Federal Power Commission. The conclusions of the Commission were that:

1. The alternative single-purpose projects are justifiable on a cost-benefit ratio basis, and the use of the estimated costs of such projects in arriving at the percentages for allocating joint costs is reasonable.

2. The principles and methods employed by TVA in allocating the joint costs of its multiple-purpose projects are reasonably adapted for the purpose.

3. The allocation of the actual joint costs of the multiple-purpose projects to navigation, flood control, and power made by TVA in its report dated November 13, 1945, is reasonable and should be accepted for the purposes of the Tennessee Valley Authority Act.

In recent years, essentially this same method, but referred to as the Separable-Cost Remaining-Benefit Theory of allocation has been found applicable by other agencies dealing with multiple-purpose developments.

In the present-day allocation of the investment in multiple-use facilities, 27 percent of the common cost is assigned to navigation, 31 percent to flood control, and 42 percent to power. The corresponding percentages for the total of direct and common costs for the multiple-purpose system are: navigation, 21 percent; flood control, 25 percent; and power, 54 percent. All costs for single-use hydro projects, steam-electric plants, and transmission system are assigned entirely to power.

Experience in multiple-use river development and operation in the Tennessee Valley has attracted the interest of individuals and nations on a worldwide basis. While this experience cannot be used as a model to be transferred intact to any location, it can be drawn upon as we attempt to find adequate methods of approach to problems of making full and balanced use of our natural resources. Trends in water control and water use show that only the fullest development will meet future needs.

In this situation there will be conflicts to be resolved. It is imperative that solutions be found in the best tradition of sound engineering evaluation of all reasonable alternatives. Negative criticism of existing methods is not enough. Civil engineers must pool their talents to find and to constructively support ways and means of achieving objective and sound solutions for tomorrow's problems.

(This article is a shortened form of the paper presented by Mr. Elliot at the ASCE Knoxville Convention, in the symposium on Multiple-Purpose River Development, before the General Technical Session, presided over by C. E. Blee, Chief Engineer of the TVA.)

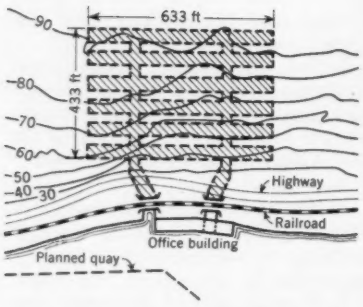


FIG. 1. Underground warehouse in Oslo, Norway, consists of six parallel chambers 633 ft long, connected by two access tunnels 525 ft long. Photo shows entrance to one of these tunnels, drilled into solid granite.

UNDERGROUND WAREHOUSE

excavated in granite

There being no reasonably level ground for a needed warehouse for Norway's capital city of Oslo, engineers investigated the feasibility of excavating a series of tunnel-connected chambers in a granite cliff rising out of the sea. Along the Oslo Fjord the mountain dips steeply into the sea, and the only available space along the water's edge is occupied by a railroad and a highway, both carved into the mountain side. Final location of the project was determined after geologists had made surveys and studied diamond-drill borings. The adopted site is in a region of good gneiss and granite rock, and on property owned by the city. The arrangement of the chambers, the two entrance adits, and the connecting tunnels, are shown in Fig. 1. The authors' firm was selected to do the work.

Rock excavated from the chambers, about 200,000 cu yd, was dumped into the steep fjord outside the adits to form access roads and future quays for unloading ships. From the shore two access tunnels 28 ft wide by 32 ft high were driven straight into the cliff for a distance of about 525 ft. Crossing these at right angles, six parallel chambers were blasted out, each 633 ft long, 46 ft wide and 30 ft high. Rock cover over the outer cross chamber is about 80 ft thick, increasing to about 250 ft over the inner chamber.

Precast panels and arches form the walls and ceiling of the two-story structures in each chamber. Between the rock and the precast elements there is sufficient space for inspection. Cast-in-place cylindrical columns support the cast-in-place second-floor slab. See Fig. 2. Nearly 7 acres of commercial storage space (290,000 sq ft) are provided in this project.

Hard-rock shooting

Rock blasting was started in the spring of 1953 at the southern entrance, where the tunnel under the railroad and highway along the shore would be the shortest. A small wooden trestle along the shore provided the first access to the work but when a sufficient level area was built up by dumping of the blasted rock, dump trucks and shovel loaders were brought in by a floating crane.

The blasting under the tracks and the road was done very carefully. First an 8-ft x 8-ft adit was driven and the rest of the section was stoped out. For the tunnels, the contractor used full-face blasting. The equipment used consisted of compressors with an air capacity of 1,400 cfm; two hydraulically adjusted jumbos mounted on trucks; two ladders for scaling loose rock, also built on trucks; one electrically driven shovel, Landsverk L-65, and four Muir Hill dump trucks.

Rock drilling equipment was of the lightweight Swedish type. The jackhammers were Atlas RH-656-4W, made in Sweden by Atlas Capco. Several makes of drill steel were used, mostly $\frac{7}{8}$-in. Bohlerit, made by Gebr. Bohler in Wein, Austria, and some Coromant from Atlas Capco. The drilling rate in the hard Norwegian granite was about 1 ft per min.

In the full-face section of 1,237 sq ft, 150 holes were driven to a depth of 13 ft. Each round pulled 11.0 to 12.0 ft. Short-delay blasting caps were used on practically the whole job. The amount of explosives varied between

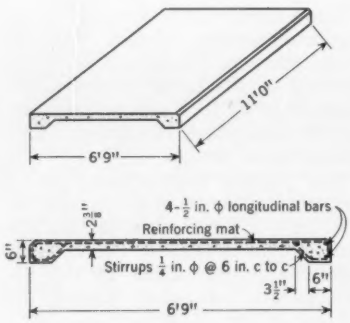
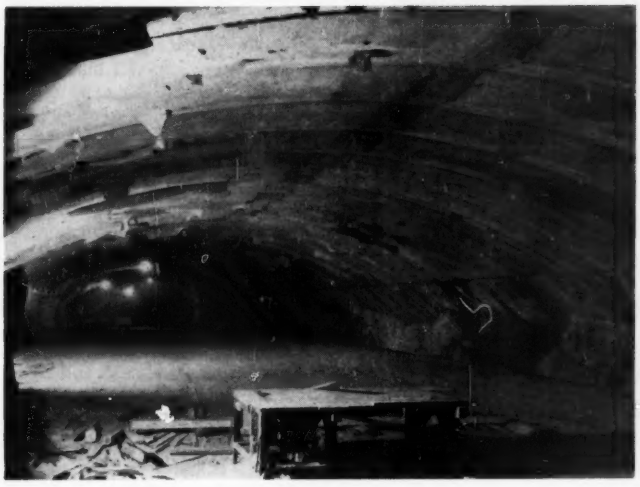


FIG. 3. Precast vacuum-processed wall elements for first story were cast underground. Photos at bottom of facing page show concrete placing (left), vacuum processing (middle), and vacuum lifting (right).



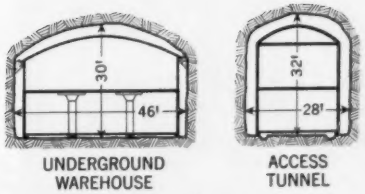
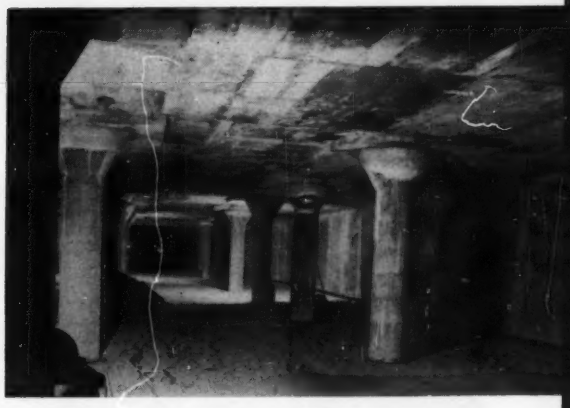


FIG. 2. Two-story underground warehouse contains 6.6 acres of storage space. Concrete wall panels in lower story (below) and ceiling arch ribs in upper story (left) are precast elements, vacuum processed after pouring. Columns supporting second story were also vacuum processed.



C. D. ZERNICHOW, Vice President
H. MOYNER, Engineer

H. Eeg-Henriksen A/S, Engineers and Contractors, Oslo, Norway

1.2 and 1.4 lb per cu yd. A maximum of 4,450 cu yd of solid rock was taken out in a week, and about 15,700 cu yd in a month. The average production in a year corresponded to 11,800 cu yd a month, or 75 percent of the maximum obtained. The lowest figure of man-hours per cu yd of rock was 0.36 for a 14-day period. With all the back men included, 0.8 to 0.9 man-hours were required per cu yd.

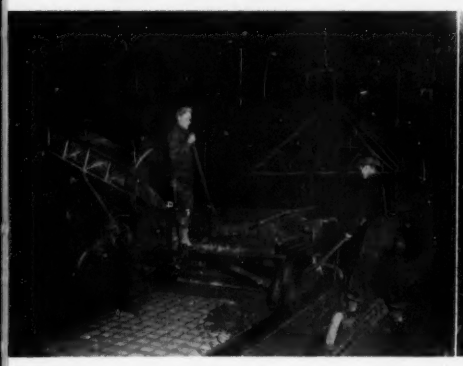
Precast units fabricated underground

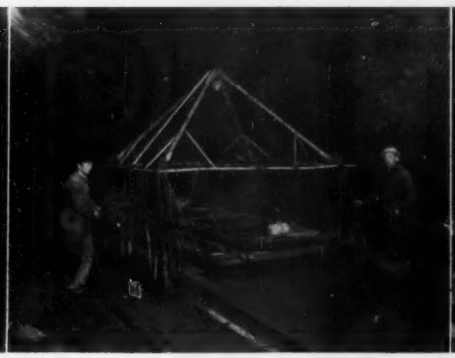
The concreting was started in the fall of 1954 while excavation was still under way. A total of 13,100 cu yd of concrete and over 1,000 tons of reinforcing steel were used. The units making up the walls and arched ceiling in the storage chambers were prefabricated. Of the 280,000 sq ft of prefabricated elements, 226,000 sq ft were treated by the vacuum curing process, which also was applied to the cast-in-place columns in the first story. The batching plant was placed in the third cross tunnel from the entrance with 200 to 230 ft of tunnel behind it reserved for storing aggregates. This central location of the batching plant inside the mountain had a special advantage in wintertime.

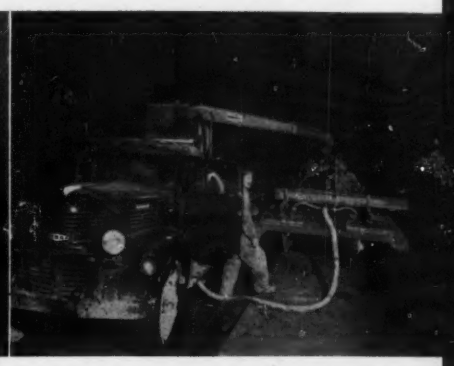
The sand was brought in to a temporary quay in barges, while the coarse aggregates were obtained by crushing the rock excavated from the tunnels. Most of the concrete was transported by truck, but some was brought in by monorail cars. When concrete had to be lifted, a rubber-wheeled loader was used. The vacuum process for curing precast concrete elements was used here for the first time in Norway, and thus was viewed with considerable interest. The contractor, H. Eeg-Henriksen A/S, is paying royalty to Vacuum-Concrete D.N.F., of Denmark, which has the exclusive rights to this process in Denmark, Norway, and Finland. The following elements were treated by the vacuum method: the wall elements in the first story, the columns in the first story, and the arch elements for the ceiling in the second story.

Precast wall elements

The main dimensions of the precast wall elements in the first story are shown in Fig. 3. These ribbed slab elements were cast in the fourth tun-







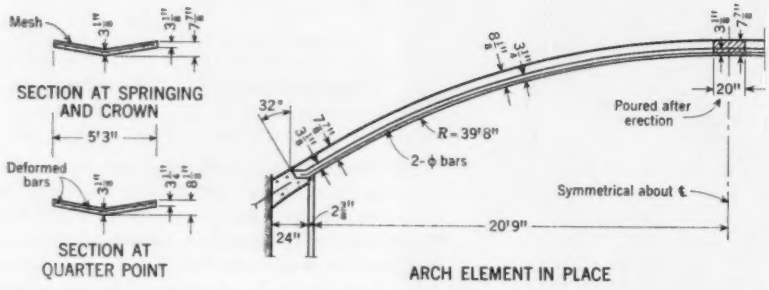
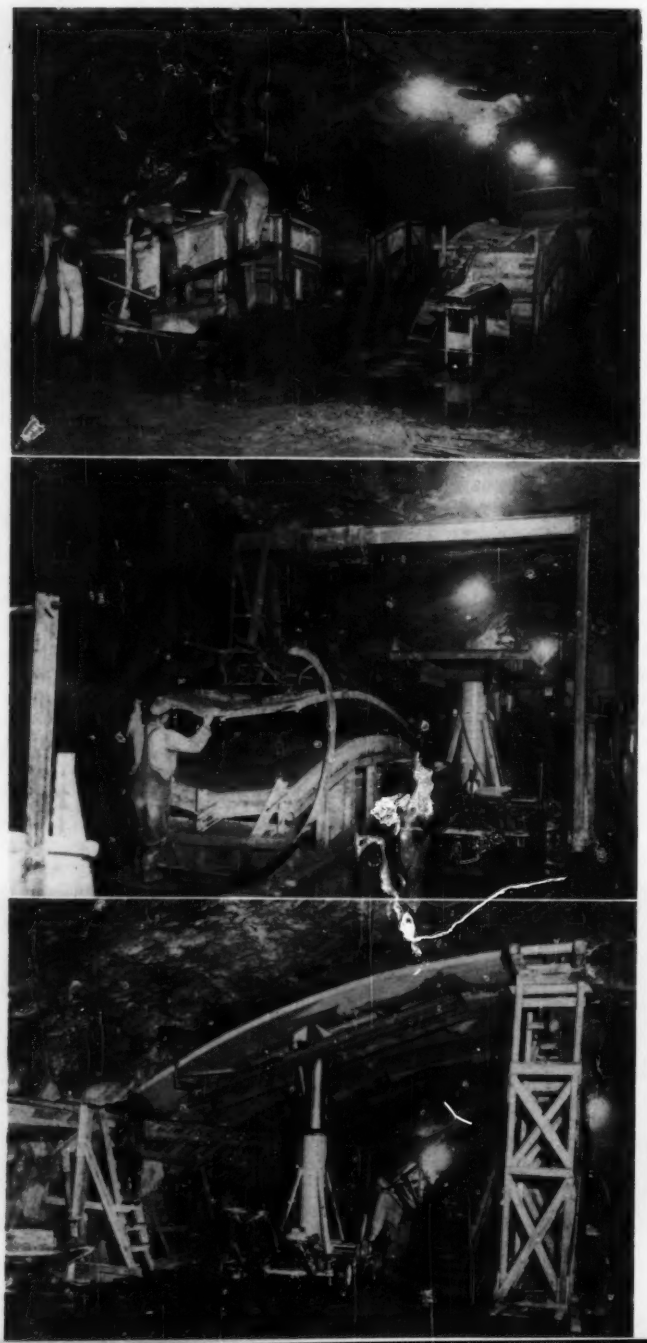


FIG. 4. Trough-shaped half-arch ribs for ceiling of upper story were cast on top of one another in stacks seven high (first view below), removed by vacuum lifters supplemented by bracket grips (middle view), and raised into position by hydraulic mounting device (lower view). Outer end of each rib rests on bracket previously poured on rock wall and other end on temporary scaffold, which was removed after concreting of space at crown between pairs of opposing ribs.



nel from the entrance, where two concrete forms were laid out horizontally, their surface corresponding to the under side of the slab, and of sufficient length for the pouring of 15 slabs in each row. The steel-channel side forms were also used as rails for the concrete placer and vibrator, which were built for the job, and pulled by an air winch. For the vacuum treatment, a mat was built covering one element of 75 sq ft. It was supported on a carriage for moving it along the row. Pipes for water, air, and vacuum were placed between the two concrete forms, and the vacuum line was connected to a movable pump during treatment.

Two vacuum pumps with a rated capacity of 270 cfm and 220 cfm at 80-percent vacuum, were each mounted on a rubber-wheeled carriage together with an electric motor and tanks, so that they could be easily moved around in the plant. This was especially important when treating the columns, which were poured in place. The wall elements were supposed to be taken out of the forms 24 hours after pouring, but on warmer days they were removed after 12 to 13 hours with a vacuum lifter. This lifter was mounted on a truck, which transported the elements from the fabrication area to the place of storing or erection. The vacuum for the lifter was supplied by a pump placed on the truck, so that the lifter could unload the elements at any suitable place, independent of the other vacuum units.

Tarpaulins were stretched under the roof rock above the forms for the wall elements to prevent dripping from the rock onto the green concrete. Special precautions against this dripping had to be taken elsewhere, especially in the spring when the snow was melting or after a heavy rain, when dripping might be considerable.

Cast-in-place columns

A total of 336 columns support the poured-in-place flat slab that divides the storage chambers into two stories. Only two specially built vacuum steel forms were used for pouring these columns, each one made up of three equal parts. The cylindrical part of the column has a diameter of 23½ in. while the height is 10 ft 9 in., and the width at the top of the capital is 4 ft 3 in. To facilitate pouring, the contractor built a high working scaffold with an air winch for hoisting up the 3-cu ft concrete buckets. The column capital was also treated internally with vacuum through a small cone inserted from the top. The form could be removed an hour after pouring when normal vacuum treatment was given.

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The ceiling in the upper story is a concrete arch with a span of approximately 42 ft 6 in., made up of prefabricated, slightly V-shaped elements, each covering half the span. See Fig. 4. The elements are circular with the same radius (39 ft 8 in.) for both the top and the bottom face, so that they could be poured in piles one on top of another. One hall in the upper story, close to the batching plant, was chosen for the fabrication of these arch elements, which were poured in seven stacks with six to seven elements in each. The top of one finished element was covered with paper, and this constituted the bottom form of the next element. The side forms could be moved upwards in equal steps of 3¼ in., corresponding to the thickness of the element at the middle. The thickness varies slightly because of the constant radius used for the top and bottom surfaces.

After the reinforcement was placed, a fairly stiff mixture of concrete was poured and vibrated with a plough-shaped vibrator, bent to coincide with the V-shape of the element. Because of the combination of the longitudinal slope and the slope in the cross section, the concrete did not keep its correct shape after vibration, and some troweling had to be done to straighten it.

The contractor made the vacuum mat by cutting out traces in two directions on one side of rubber plates ⅜ in. thick, and glueing a foam-rubber strip along the edges for better tightening. For the 1,300 arch elements, only four of these rubber mats were used for the vacuum treatment, each mat approximately 5 ft square. A specially built vibrator was used to form the support end of the element.

Some of the paper used as an intermediate layer when pouring the elements stuck fast and had to be removed from the under side of the ceiling before it was painted. To facilitate this, the paper was laid on the green concrete before the vacuum treatment was applied. It was found that the vacuum sucked the water out through the paper, and that, although the paper stuck partly to the top side of one element and partly to the under side of the next, it was easily removed. Fabrication and erection of the arch elements went on continuously. This gave the elements one week of curing before they were erected with a vacuum lifter.

Transportation from the fabricating area to the place of erection, and the erection itself, were done with a mounting device which mainly consisted of a hydraulically operated cylinder mounted on a rubber-wheeled carriage driven by a gas engine. As a safety precaution, the vacuum lifter was equipped with hooks to carry the element in case the vacuum should fail. This proved to be a wise precaution because the electric power failed more than once when the vacuum lifter was in operation, and thus cut out both the motor driving the vacuum pump and the lights.

Columns supporting flat slab of second floor were cast in place, then vacuum processed to remove excess water. Steel forms for columns were removed within an hour after pouring. At left, one part of three-piece form is being placed; at right, pouring is under way.

During erection the arch elements were supported with one end on a previously poured bracket on the rock wall and the other on a temporary scaffold running along the center of the room. When the space between each two opposite elements was poured, the scaffold was removed.

Each half of the plant is ventilated by a separate unit, one unit being located in each of the two entrances.

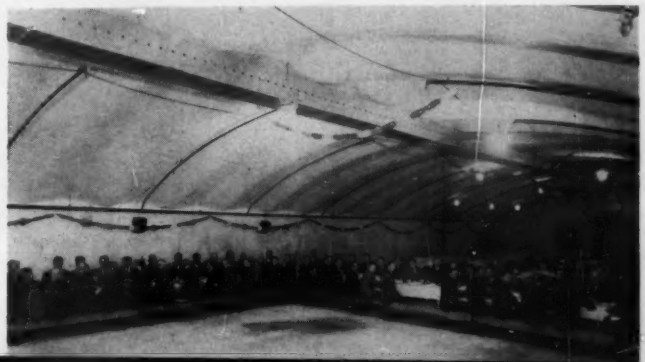
The first chambers were put in use in March 1956 and the whole structure is now completed and in use. The warehouse is only served from the harbor, but the harbor is connected with the highway by two first-class access roads, one running through a tunnel, the other over a bridge.

The total cost of the warehouse was 16 million Norwegian crowns. In Norway underground warehouses are slightly more expensive to build than ordinary surface ones, but the cost of heating and cooling is considerably lower, so that they are economical. (Some of the chambers are used for the deep-freezing of food.) Also, of course, an underground structure is safer in wartime. In this particular case, the cost of the land was saved and also new harbor areas were provided by the fill taken from the excavation.

Although the warehouse is on city-owned land, it is not municipally owned. The owner is Ekeberg-hallene Ltd. The City of Oslo endorsed a loan of 15 million crowns for the building of the structure, and after 60 years ownership will be transferred to the city (its Harbor Department) without expense to it.

Messrs. John Engh and Peer Qvam conceived the idea of the underground structure and served as its architects. Olaf Abel Engh was the consulting engineer and designer of the structural features, which were somewhat altered in collaboration with civil engineers of the writers' firm, H. Eeg-Henriksen A/S, the engineers and contractors for the work.

Party for construction force was given in completed underground warehouse by its owner, Ekeberg-hallene, Ltd. Note sprinkler system for fire protection and air conditioning duct along center of ceiling.



CARQUINEZ TOLL BRIDGE PROJECT – Part I

FIG. 1. Traffic across three-lane Carquinez Bridge, built in 1927, has grown to 10 million cars per year. To relieve congestion at Carquinez Strait crossing, a $46,000,000 parallel bridge is now under construction by State of California.

Record approach cut and use of slip-forms on 47 high interchange piers

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"Big Cut" takes shape at upper left, where lower bench, nearest camera, is at grade and marks beginning of Crockett Interchange. Piers for this interchange march to waterfront at right.

In the five years following the close of World War II, highway traffic across the Carquinez Bridge, built in 1927 across an arm of San Francisco Bay, more than doubled until it reached a count of over ten million cars per year. The three-lane roadway of this bridge therefore has become a very serious bottleneck which hampers the free flow of highway transportation between San Francisco and the Sacramento Valley. See Fig. 1.

Realizing this situation, the California Legislature in the summer of 1955 passed legislation making it possible for the California Toll Bridge Authority to build two new bridges across Carquinez Strait to be financed by the sale of revenue bonds not to exceed $80,000,000. The first of these is the structure parallel to, and about 200 ft upstream from, the existing Carquinez Bridge on U.S. Highway 40, and the second is the bridge about 6 miles upstream, between the cities of Benicia and Martinez on State Route 75.

Since plans for the parallel Carquinez span had already been prepared, it was possible to advertise for bids on this part of the project in October 1955. Bonds in the amount of $46,000,000 were sold in December 1955 and construction officially started the last part of the same month.

Plans for the bridge at Benicia-Martinez are nearly complete, and this work will be advertised some time in 1957, as soon as right-of-way negotiations have been completed.

Major contracts under way

The major contracts on the project which includes the bridge parallel to the existing Carquinez span are as follows:

1. Work on 2.9 miles of approach freeway to the south of the bridge, awarded to the joint venture of Ferry and Crow for about $7,200,000.

2. The Crockett Interchange structure joining the main bridge and the freeway contract, awarded to Peter Kiewit Sons' Company for $4,700,000.

3. Foundation work for the main bridge, awarded to Mason and Hanger, Silas Mason, Inc., and F. S. Rolandi, Jr., Inc., for about $5,500,000.

4. Superstructure of the main bridge, awarded to the U.S. Steel Corporation, American Bridge Division, for about $9,500,000.

5. Freeway work for a 1.2-mile stretch at the north end of the bridge, awarded to Fredrickson and Watson Construction Company-Ransome Company for approximately $1,800,000.

6. Construction of the Administration Building and Toll Plaza, awarded to W. J. Kubon Company for about $500,000.

7. Navigation lights and maintenance air lines, awarded to Hart & Hynding for about $125,000.

8. Toll collection equipment, to Scott Buttner Electric Co. for $242,500.

9. A contract for final connections to the existing bridge, to be advertised next summer.

Record "Big Cut"

The $7,200,000 contract for the approach freeway to the south of the bridge contains one of the largest cuts in the history of highway building in California, and possibly in the United States. Called the "Big Cut," this excavation has a width across the top of 1,370 ft and varies from 245 ft deep at the center line to 350 ft deep when

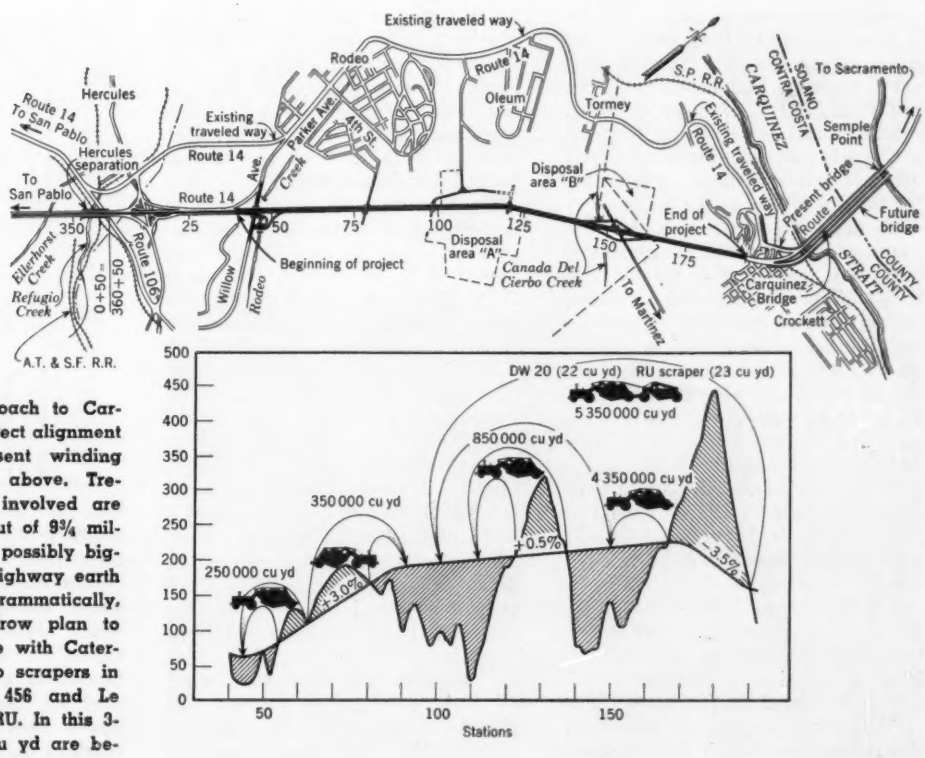


FIG. 2. New south approach to Carquinez Bridge provides direct alignment as compared with present winding shore route. See plan, above. Tremendous cuts and fills involved are seen in profile, below. Cut of 9¾ million cu yd at Sta. 180 is possibly biggest in history of U. S. highway earth moving. As shown diagrammatically, contractors Ferry and Crow plan to move 55 cu yd at a time with Caterpillar DM 20 hauling two scrapers in tandem—Caterpillar No. 456 and Le Tourneau Westinghouse RU. In this 3-mile section, 11 million cu yd are being moved on two-shift basis.

measured from the highest point on the cut. It contains 9,700,000 cu yd, a large percentage of the 11,200,000 cu yd in the total contract. See Fig. 2.

This cut was decided on after considerable study of other possible lines and after consideration of an alternative tunnel design. Considering first cost, maintenance, right-of-way, highway user costs, convenience, safety, and disturbance to existing property, the line chosen appeared to have the advantage over all others. Comparing a cut section to a tunnel, there were two factors that made the cut a decidedly more satisfactory solution—first cost and safety from earthquakes. Since the tunnel would pass through a faulted, unstable area, its lining would have to be heavy and costly to construct, and throughout its life it would be subject to considerable danger from earth movement.

Preliminary borings indicated that an older Cretaceous sandstone and sandy shale had been thrust over younger Eocene shale, intermixed with a steeply upturned Miocene stratum consisting of interbedded shale and hard sandstone. Water was also found in sufficient quantities to make subdrainage an important problem in the design of the cut.

Based on the findings from the borings and the studies of general terrain and earthquake conditions, the following design for the cut section was chosen. Slopes were set at 2:1 with 30-ft benches every 60 ft of elevation. At grade the cut provides for two 36-ft paved roadways, with provision for two additional 12-ft lanes, 9½-ft outer shoulders, and 2-ft shoulders adjacent to the 4-ft raised median strip, plus a debris trough on each side. This makes the cut 200 ft wide at the bottom.

To drain the trapped underground water, which was found in aggravating quantities, horizontal perforated casings of 2-in. diameter will be drilled laterally into the cut slopes at locations and spacings to be decided by the engineer as excavation advances. It is anticipated that at least 24,000 lin ft of these drains will be required to provide adequately for the subdrainage and structural stability of the cut section. The 30-ft benches will also have ditches to collect surface water and seepage from the horizontal drains. In addition, the benches will provide access for maintenance equipment.

The Big Cut will yield about 2,400,000 cu yd of material in excess of that needed for roadway fills. This material is being placed in disposal area "A," shown in Fig. 2, to improve Union Oil Company property in return for the right-of-way which this company provided for freeway construction.

The shale and sandstone encountered by the contractor during excavation has varied in hardness. It has been found possible to excavate by ripping at all locations except the cut at about Sta. 130, which is the first cut to the south of the Big Cut. Here it is necessary to shoot and excavate with a 2½-cu yd shovel and use 8-cu yd dump trucks for disposal.

As can be seen in the profile of Fig. 2, there is a haul of 7,000 to 8,000 ft for about 5,350,000 cu yd from the Big Cut. For this operation the contractor proposes to use Caterpillar DW 20's, each hauling one scraper in tandem—a 22-cu yd Caterpillar No. 456 and a 23-cu yd Le Tourneau Westinghouse RU. Three of these rigs are now successfully undergoing trial operation, and as soon as the long haul starts, about 10 additional tandum rigs will be put in operation.

The maximum daily yardage moved to date has been about 32,000 cu yd. By December 1, 1956, the contractor had completed 4,200,000 cu yd. Bid price for the 11,200,000 cu yd of excavation is 25.6 cents per cu yd.

Crockett Interchange

The Crockett Interchange serves as a connecting viaduct between the Big Cut and the south end of the main bridge. It also acts as an interchange structure for the town of Crockett. See Fig. 2. This structure is of conventional steel-girder design, with span lengths varying from 120 to 180 ft. The girders are supported on 47 reinforced concrete piers which vary in plan from a solid shaft 6 ft x 22 ft to a boxed shaft 20 ft x 76 ft, and in height from 20 ft to 123.5 ft, the average height being close to 70 ft.

The piers were all designed without batter or offsets so that slip-form construction could be used by the contractor if he so desired. Contractor Peter Kiewit Son's Company investigated this method and decided to adopt it, using slip forms developed by B. M. Heede, Inc., an international organization with headquarters in Sweden. Slip forms have been used before in the United States but they have been of the manually operated screw-jack type. This type is cumbersome to keep level, and troublesome to keep moving at a constant rate at all points.

The development of an automatic controller for operating a series of hydraulic ratchet jacks (Fig. 3) has greatly simplified slip-form procedure. These jacks, located about 7 ft apart, are supported and, as it were, climb up, high-strength steel rods of 1-in. diameter which extend down into the concrete. Each rod passes through a metal sleeve 3 ft long which prevents the rod from becoming bonded to the green concrete. After the last pour on the pier, the rods are salvaged and the holes filled with grout.

At the start of each pier, after the reinforcing steel, jack-supporting rods, and forms have been carefully set on the footing, the 4-ft-deep form is filled in layers of about 8 in. As soon as this concrete has set sufficiently, which may be in about 3 hours, the jacking operation is started. Once jacking is under way, the form is "slipped" up at the rate of 5 to 14 in. per hour. The rate of rise is dependent of the rate of curing, which changes with the ambiant temperature and wind velocity. An experienced operator determines the pace at which the form moves upward by pushing a thin steel rod down into the green concrete.

When the concrete below is exposed as the form rises, its surface is finished by troweling. This is done quickly and easily. Occasionally small pockets caused by rocks gouging the slides during slipping must be filled and finished. To facilitate this part of the work, a finishers' platform is hung below the form on the outside of the pier (also inside if the pier is hollow). Very little finishing inside was necessary, however. This platform moves up automatically as the form rises.

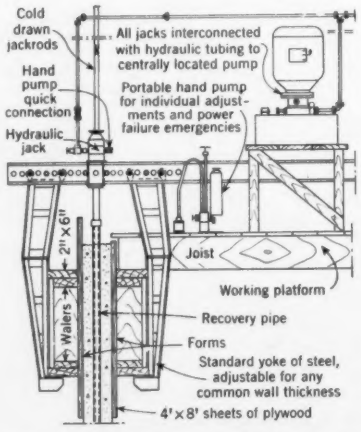

Cold drawn jackrods
All jacks interconnected with hydraulic tubing to centrally located pump
Hand pump quick connection
Portable hand pump for individual adjustments and power failure emergencies
Hydraulic jack
2" x 6"
Joist
Working platform
Waler
Recovery pipe
Forms
Standard yoke of steel, adjustable for any common wall thickness
4' x 8' sheets of plywood

FIG. 3. Slip-form equipment here shown was used for 47 reinforced concrete piers which support south approach viaduct to bridge, of conventional steel-girder design. Piers, of which highest is 123.5 ft, were designed for slip-form method, characterized as safe and fast (20 ft per day) for piers over 40 ft high. Contractor Peter Kiewit Sons' Company obtained automatic jacking equipment developed by B. M. Heede, Inc.

For curing, a water pipe fitted with fog nozzles is hung below the finishers' platform. This keeps the exposed concrete constantly moist and provides excellent curing conditions even during hot windy weather.

Pouring is carried on continuously 24 hours a day, which at the average rate of 10 in. per hour provides a progress of about 20 ft per day. On piers over 100 ft high, that cannot be completed in a five-day week, operations are shut down over the week end and an operator is left in charge to keep the form moving the very small amount sufficient to prevent bond until the slip form comes to within 6 to 12 in. of the top of the concrete.

To check piers for verticality, three targets are placed on each end and at the center of one side. One target is placed near the bottom of the pier, one on the slip form, and one on the reinforcing-steel template above the form. Water columns in transparent plastic tubes located at strategic points on the form are also used to check for possible listing. As soon as a small deviation is noted, corrective measures are started by hand jacking at the low points. Corrections must be made gradually.

Comparative costs between slip forms and conventional forms are not available. However, on a job with a reasonable number of piers over 40 ft in height, there appears to be an excellent opportunity for economy.

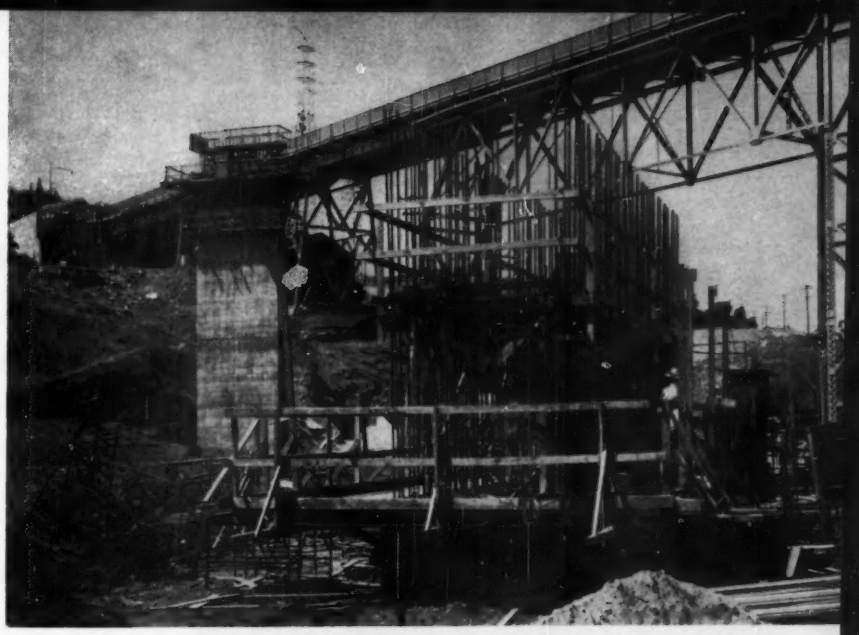
Toll plaza with 16 booths

The toll plaza will be located about 1,000 ft from the north end of the main bridge on the Solano County side. It will consist of an administration building and 16 one-side toll booths of modern barrier type, with provision for four additional booths should future traffic require them. Each toll booth will be equipped with automatic axle counters and photoelectric vehicle counters.

There is to be a nominal fee of 25 cents for passenger cars, and trucks will be charged by the axle rather than by weight. Administration of the toll collection will be under the jurisdiction of the California Division of Highways and will be operated by the same staff now operating the San Francisco-Oakland Bay Bridge, the Richmond-San Rafael Bridge, San Mateo-Hayward, and Dumbarton Toll Bridges.

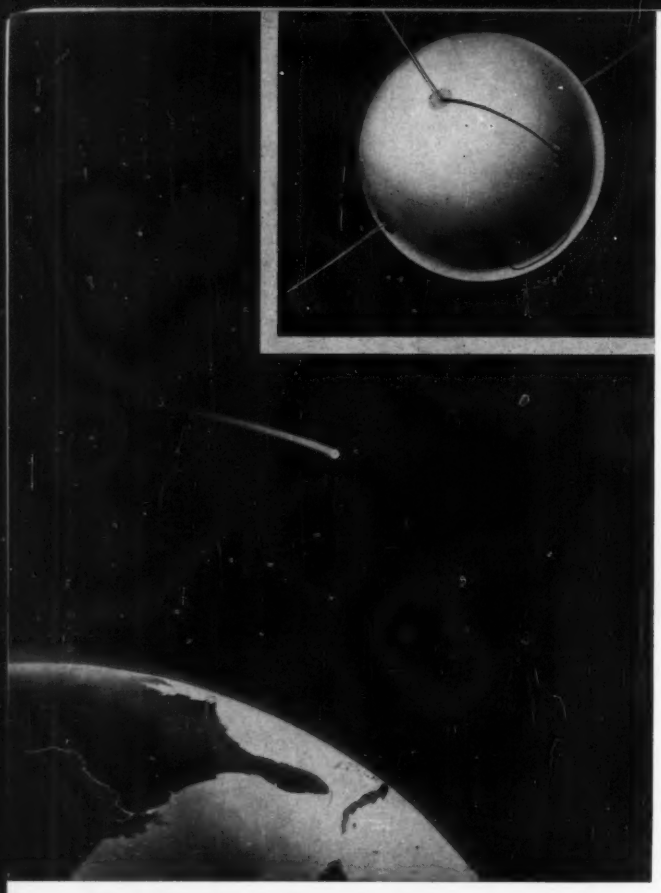
Part II of this article, which is scheduled for February publication, will cover the substructure and superstructure of the bridge which parallels the present Carquinez Bridge.

The Carquinez Bridge Project should be completed by October or November 1958. All the work in connection with this project has been assigned to the California Division of Highways by the California Toll Bridge Authority.



Concreting of piers in Crockett Interchange is under way by slip-form method. On piers in foreground, steel reinforcing and jack-supporting rods are in place. On pier at left, finishing platform is seen suspended from slip form while, at top, platform for setting reinforcing steel is clearly visible.

Heavy equipment moves earth in the "Big Cut," which has top width of 1,370 ft and depth of 245 ft at center line.



Earth satellite has magnesium shell

JAMES S. KIRKPATRICK

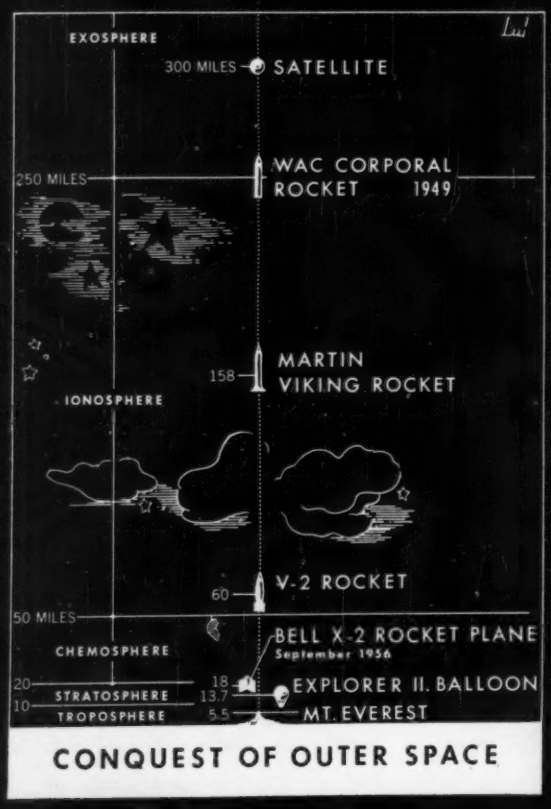
Vice President, Research and Development,

Brooks & Perkins, Inc., Detroit, Mich.

Just a little more than fifty years ago, in 1903, man first lifted himself off the ground for a few hundred feet in a heavier-than-air craft, and flew at a speed little greater than that of a race horse. This feat by the Wright Brothers was one of the great achievements of history. About 25 years later, Charles Lindbergh flew across the Atlantic, a distance of 3,600 miles in 33½ hours. This flight was accomplished without elaborate instrumentation. In 1935 Captain Anderson and Captain Stevens achieved a long-standing international altitude record of 72,400 ft (approximately 13.7 miles). This was in a free balloon flight with the men carried in a magnesium gondola—one of the first applications of magnesium sheet for an air-borne structure. Scientific data of incalculable value were obtained during this flight.

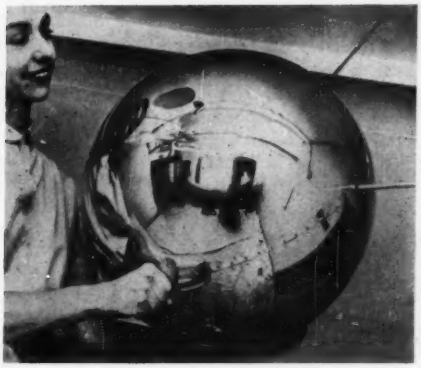
During the next ten years, the development of power plants and electronic equipment made possible heights and speeds of flight which at that time were considered phenomenal. Toward the end of World War II, German scientists developed the V-2 rocket, which reached an altitude of 60 miles above the earth (Fig. 1). Even the most conservative realized that a new age of flight had arrived.

Four years later our own scientists had reached the astounding height of 250 miles by using a Wac Corporal as the second-stage of a rocket. The first-stage consisted of our own development, the Viking Rocket. Again sci-



Top:
Earth satellite will be a sphere of 20-in. diameter with shell of AZ-31 magnesium alloy. Including instruments, it will weigh 21 1/2 lb. If present calculations prove accurate, it will circle earth at altitude of about 300 miles.

Left:
FIG. 1. Greatest altitude so far achieved by rockets is 250 miles. Satellite's altitude is planned to be 300 miles.



Mirror surface of satellite reflects laboratory surroundings, including canvas on floor.

entific data of great value were obtained. In October 1956 NACA (National Advisory Committee on Aeronautics) announced the flight of a four-stage guided missile which reached a speed of almost 7,000 miles an hour, or ten times the speed of sound. This missile attained an altitude of more than 200 miles.

After the untold milleniums of being earth bound, man in a little more than fifty years has learned how to fly and how to send unmanned vehicles at speeds and to altitudes which indicate that the conquest of space has begun. But before man can fly outside the atmosphere of the earth, extensive surveys must be made of the conditions existing outside this atmosphere. The tools and methods for accomplishing such surveys are rapidly coming into existence.

International Geophysical Year

It is important to accumulate in a short period of time data on the Universe. Scientists all over the world are joining in a coordinated effort known as the International Geophysical Year (IGY). This is an artificial year of 18 months which extends from July 1, 1957, through December 31, 1958. During this Geophysical Year, approximately 45 nations will be working together in the study of the earth, the stratosphere, and the sun. In July of 1955, President Eisenhower announced that the United States planned to launch small, unmanned, earth-circling satellites as part of its program of participation in the International Geophysical Year. To accomplish this, Project Vanguard was assigned to the Department of Defense in cooperation with the U. S. National Committee for the International Geophysical Year. Two organizations, the National Academy of Sciences and the National Science Foundation, sponsored this country's participation in the IGY. The Vanguard program, under the Department of Defense, is an Army, Navy, and Air Force project, under Navy management by the Chief of Naval Research. Facilities of all three services are being made available to the project. The Naval Research Laboratory is responsible for establishing the technical program for the Vanguard. Their responsibility includes producing the three-stage rocket vehicle, launching the satellite, certain phases of the radio tracking of the satellite, and the coordination of this tracking. The responsibility of building the satellite has been given to Brooks & Perkins, Inc.

Because 1,000 lb of launching vehicle is required for every pound of weight of the satellite itself, it is absolutely essential that the lightest possible structural material be used. Studies of various materials established that the material should be a metal. Magnesium was chosen because it is the lightest metal available commercially, it can be fabricated, and it has the necessary strength and stiffness.

Hollow sphere of magnesium alloy

This tiny moon, the Earth Satellite, will be a hollow sphere 20 in. in diameter, made of AZ-31 magnesium alloy. The magnesium skin will be 0.030 in. thick in most areas. Certain areas will be somewhat heavier where additional strength is required. These heavier areas will transmit loads from highly stressed areas into the skin itself. Each half of the sphere will be drawn from a single sheet of magnesium alloy.

Certain secondary operations of spinning will be required where the contour varies from that of a true hemisphere. The two halves of the sphere will be joined, and the sphere machined and polished to produce a surface utterly smooth and mirror bright. Many strengthening pieces, battery supports, instrument attachment brackets, radio antenna supports, and built-in pressure chambers are required in the internal structure of the sphere. Many of these parts will be gold-plated magnesium.

The earth satellite, with instruments closely packed inside the sphere, will weigh approximately 21½ lb. This weight will doubtless vary slightly with different satellites depending on which sets of electronic equipment, telemetering equipment, etc., are used for a specific flight. The antennae will be folded upward into the protective cone. When released in the upper atmosphere, they will fall into place perpendicular to the tangency of the sphere at the attaching points. The satellite itself will weigh only a small fraction of the total weight of the package. The bulk of the weight will be in the internal equipment.

Rocket flights of short duration

Up to this time, high-altitude research has been conducted by using rockets. The great value of rockets for this purpose is that they make possible on-the-spot measurements in otherwise inaccessible areas. While such observations are more direct, they are less subject to misinterpretation than observations from the ground. A rocket fired straight up completes its flight in a matter of minutes. We are able to observe conditions above the atmosphere for only a very short time. The satellite will remain aloft for a relatively long period of time. During this longer period, it will enable us to make certain scientific observations which would not be possible on a short trip.

Many scientific groups have recommended that experiments be conducted in the upper atmosphere. The size limitation naturally restricts the amount of experimentation that can be accomplished by any one satellite. Approximately 10 lb of instrumenta-

tion can be carried on any one flight. Even with this weight and space limitation, modern electronics has devised many pieces of equipment which are light enough and small enough to accumulate extensive data during the life of a satellite. Even if the satellite carried no instrumentation whatsoever, much valuable data could be gained by tracking it. Better geodetic measurements could be made, for instance.

Information sought

Some of the information that may be secured from satellite flights is:

1. Determination of the absolute value of G (force of gravity)
2. More accurate maps of major land masses and bodies of water
3. More accurate information on the shape of the earth
4. New frequencies for long-range communication
5. More accurate weather charting and forecasting
6. More information about ultra-violet and cosmic rays
7. More about temperature conditions in outer space and about the effect of air friction on the development of high temperature
8. New clues concerning radiation effects
9. More information on ionization
10. Actual atmospheric densities at high altitudes
11. Penetration of a body in space by meteoric particles
12. Much-needed experience for progressing to the next steps in satellite development, which may eventually lead to space flight.

Three-stage rocket

The vehicle for carrying the satellite into its orbit 300 miles above the earth will be a three-stage rocket. The prime contractor responsible for the vehicle is the Glenn L. Martin Company of Baltimore, Md. Although the rocket is known to have been invented some time in the twelfth century by the Chinese, it is only in the past few years that rockets have become a tool of research. The scientists and engineers who are the rocket experts of today are still relatively young men.

The rocket that will be used to send up the first earth satellite is 72 ft long and 45 in. in diameter (Fig. 2). The first-stage will be a 27,000-lb thrust rocket motor being built by the General Electric Company. The first-stage is a booster for the other two.

The second-stage rocket is of liquid-propellant type, attached to the forward end of the first-stage rocket. The second stage, being built by the Aerojet General Corporation of Azusa, Calif., contains the "brains" of the entire launching vehicle—the guidance system for the whole flight.

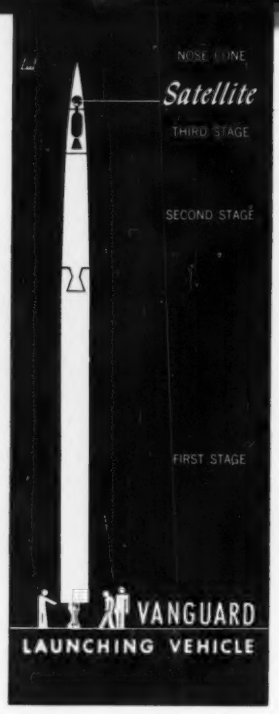


FIG. 2. Satellite will be fired into orbit 300 miles above earth by three-stage rocket. This rocket employs solid propellants and will accelerate satellite to final velocity of 18,000 mph.

The third-stage rocket employs solid propellants. The Grand Central Rocket Company of Redlands, Calif., and the Allegheny Ballistics Laboratory of Cumberland, Md., are both working on the third-stage power units.

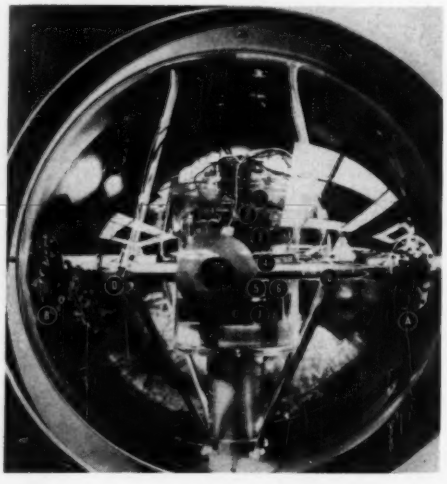
The first-stage rocket will burn for 131 seconds, and will be burned out at a height of approximately 40 miles. The vehicle will then be traveling at about 3,000 miles per hour. The second-stage burnout will occur about 140 miles up, and the speed will be about 9,000 miles per hour.

The nose cone will separate from the second stage, and coast at 300 miles up and in proper relationship to the orbit. The third-stage rocket will then fire, bringing the unit up to a speed of 18,000 miles per hour. The protective cone will be blown off, and the separation mechanism will eject the satellite into its orbit. See Fig. 3.

The three-axis reference system will be carried in the second-stage rocket, and is being built by the Minneapolis Honeywell Regulator Company of Minneapolis, Minn. The magnetic amplifier autopilot is being built by the Vickers Electronic Division of Vickers Incorporated, St. Louis, Mo. The reference system will furnish instructions to the autopilot unit, which will correct the gimbal-mounted rocket motors in flight.

The launching site for the "Van-

Inside of satellite is seen in model. Proposed instrumentation includes: (A) cell operating on solar energy to reset recording devices on each orbit around the Earth, (B) ultra-violet-ray detector, (C) oxides to measure temperatures, (D) erosion gage to measure impact of collisions with foreign objects, (1) transmitter for relaying data to Earth, (2) amplifier to detect collision with micro-meteors, (3) storage unit to record data from amplifier, (4) device for transmitting data to ground stations, (5) memory unit to give out stored data as satellite passes over recording stations, (6) current amplifier to measure ionization from ultra-violet radiation, (7) mercury batteries for power.



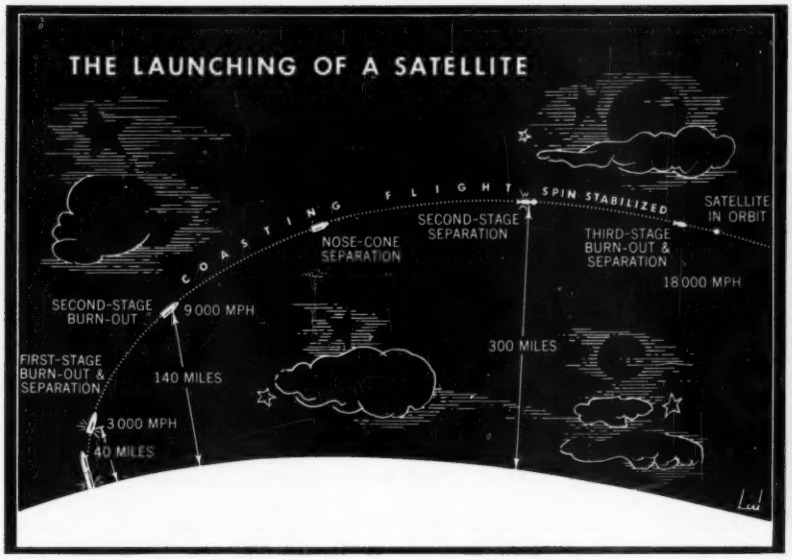


FIG. 3. Stages and trajectory of launching satellite are shown schematically above. Orbit after third-stage burnout is shown at right.

FIG. 4. Relative periods of revolution are shown for various altitudes. In an orbit 200 miles up, life of satellite would be only 15 days. At anticipated height of 300 miles, satellite could last for about a year.

guard Satellite Vehicle" is Patrick Air Force Base, Fla., better known as the Armed Forces Missile Test Center. The satellite will be inclined toward the equator when launched, probably at an angle of 35 to 45 deg latitude. It has been estimated that if the ascent trajectory now calculated is achieved, and the satellite reaches a height of 300 miles, it could last for one year. If the height reached is 200 miles, the lifetime will be only about 15 days, and if the height is only 100 miles, the lifetime will be less than one hour. For periods of revolution see Fig. 4. Once the satellite is in its orbit, the minitrack radio system will allow it to be followed and will localize its time of arrival at any given point on the orbit. Data can then be given to other observation stations, which under proper conditions can make optical observations. Observation stations are planned at the following locations:

Blossom Point, Md.
Fort Steward, Ga.
Batista Field, Havana, Cuba
Coolidge Field, Antigua Island
Rio Hata, Panama
Mt. Cotopaxi, Quito, Ecuador
Ancon, Lima, Peru
Autofagasta, Chile
Peldehue Military Reservation, Santiago, Chile
Navy Electronics Laboratory, San Diego, Calif.

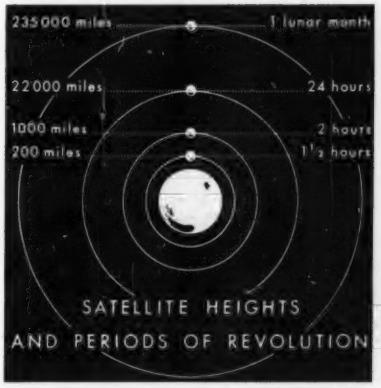
Enough launching attempts are planned, according to the National Academy of Sciences and the Defense Department, to establish at least one satellite in a durable orbit. As many as 12 attempts may be made during the International Geophysical Year.

Manufacturing the satellite

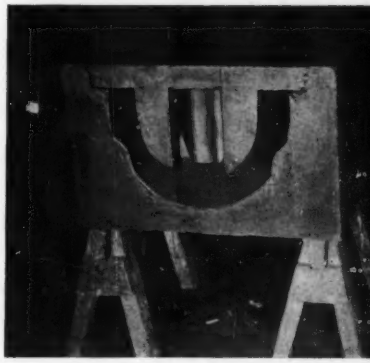
In the manufacture of the satellite's shell and frame, the first operation will be a deep-drawn hemisphere. The magnesium is heated in an oven to 650 deg F, and the die is heated to the same temperature. The draw die consists of a punch and two rings. The flat metal blank is placed between the draw rings, and the stamping is accomplished by pulling the magnesium over the heated punch. After the metal has cooled to room temperature, the stamping is trimmed.

The next operation is to place the hemispherical stamping over a spinninglathe tool, where certain operations of contour are performed manually. This consists primarily of adding a pressure-ring area to the concave side of the stamping. Again the spinning operation is accomplished at approximately 600 deg F.

Covers are then welded into the depressions which have been spun on the lathe. The hemisphere is placed on a lathe, and the gage of the metal is machined from about 0.050 in. down



Cast-iron sand mold is used to pour spin-block for tooling satellite shell to thickness of 0.030 in.



to 0.030 in. The excellent machining characteristics of magnesium allow this type of machining to be accomplished more readily than it could be on any other metal. The internal framework which carries the load of the electronic gear is made up of welded magnesium tubing. The tubing is hot formed to shape, placed in a welding fixture, and the components welded into one structurally sound framework. All welding is accomplished by a-c welding current with a high-frequency ionization current superimposed. The entire molten area is covered by an envelope of argon gas so that oxygen cannot contaminate the metal while it is in the molten condition.

After the internal framework and equipment have been completed and assembled, the two hemispheres are brought together at the equator and fastened. According to a recent Navy decision, the Vanguard Satellite, to be launched in the summer of 1957, will be coated with pure gold 1/20,000 inch thick.

New magnesium alloy used

Magnesium is used in certain other parts of the launching vehicle. A new magnesium alloy HK-31 contains 3 percent thorium and has the ability to resist temperatures up to 750 deg F. This allows the designer to use the lightest of all structural metals with good resistance to heat, especially for the short periods of time which are sufficient in many rocket programs. The magnesium industry, like the rocket industry, is young. In the past ten years many new alloys have been developed and are on the way. The satellites demonstrate that the lightest of all structural metals can be fabricated, formed, welded, and held to extremely close tolerances.

We are exploring the vast areas of the unknown and determining certain data that will be required if man is to have a better understanding of outer space. Paul Walsh, Deputy Director of the Vanguard program, has said, "At present we are like the fish living at the bottom of the deep ocean. Above us is a vast sea of matter. We are just beginning to move toward the lighter densities above us. When we have learned how to reach the upper area, we will immensely increase man's knowledge of the universe in which he lives."

(This article was originally presented as a paper by Mr. Kirkpatrick at the ASCE Pittsburgh Convention, before the Construction Division session presided over by Charles M. Davis, Chairman of the Division's Executive Committee.)

ATOMIC POWER APPRAISED—Role of

C. V. ROSEBERRY, Manager of Commercial Atomic Power Activities,

Today we hear much about the wonders of the atomic age. Some would have us believe that in nuclear science lies the solution to world peace, long-term energy requirements, and the elimination of many problems attributed to the frailty of man. The mere mention of atomic power causes investor purse strings to loosen and the average imagination to run wild.

Many fabulous predictions have been made of the wonders to be accomplished by this young upstart in our scientific family. And there have been dire forecasts of unknown disasters that will plague the footsteps of nuclear scientists as they move further beyond the present boundary of knowledge and experience. But let's confine ourselves here to an examination of a few of the engineering problems encountered in the development of atomic power. Let's leave the bomb behind its curtain of security. Also, let's leave the discussion of the application and use of the many nuclear by-products to another time.

Engineers have a keen interest in the technological problems associated with development of this new power source and generally understand the far-reaching economic implications. However, don't leap to the conclusion that King Coal and Queen Oil are about to abdicate their thrones. Far from it. Atomic power will not replace but will only supplement conventional fuels for many years to come. The demand for power will require all the fuels we can mine, drill, or harness in this power-hungry world. Whether coal and oil last for one hundred years or much longer, they will be needed and used. Where coal and oil are plentiful, these fossil fuels can be used to produce electric power cheaper than it can be with atomic fuels such as uranium.

With this we are provided with material for one of the hottest debates since the days of Lincoln and Douglas. When and where will atomic power become economically competitive with coal and oil? What type of atomic power plant will be the most economical?

No one knows the answer to those two questions at this moment. Many educated guesses are being made. But until the different types of atomic power plants now on the drawing boards and under construction are completed and have been in operation for a year or two, there is no way of predicting accurately what their actual cost of operation will be. We are certain, however, that in the United States the cost of power from nuclear fuels as compared to that from conventional fuels will be relatively higher for some time to come. This will be true in spite of the fact that we know more about building nuclear plants than any other country in the world.

Cheaper power not anticipated

Until we are able to bring nuclear power costs down to economically competitive levels in this country—a goal that is at least five and perhaps ten years away—the profit incentive to build nuclear plants will be lacking. In spite of this, if we are to maintain our position of leadership in the field, and if we are to live up to our commitments to develop the peaceful uses of atomic energy, we must forge ahead and build nuclear power plants. These plants must be built and operated in order to test new engineering concepts, to gain experience, and to provide more advanced information useful in designing economical plants. We must face up to the problem of who is to finance this development—private industry or the government, the stockholder or the taxpayer. We must determine the urgency of the situation and decide just how fast to proceed.

Nuclear power will never be cost-free. Even if the solution to technological problems would produce "zero" fuel costs, power users would still have to pay capital carrying charges plus operating, maintenance, and transmission expenses.

Nuclear power should however provide many countries of the world with the same type of incentive for industrial development that we have enjoyed over the years because of our abundant supply of fossil fuels. Although the incentives industry obtained from the de-

civil engineer in reducing costs

Westinghouse Electric Corp., Pittsburgh, Pa.

velopment of the steam engine, the steam turbine, and vast electric power transmission networks were a major factor in our industrial development, they were not, at first, cost-reducing. The incentives did, however, enable basic industry to grow big and competitive and brought about tremendous growth in associated industries.

Engineering solutions required

What are some of the day-to-day engineering problems that must be solved in the development and use of this new source of heat? A few examples of these problems will be of interest. In the accompanying photograph, I am standing beside a scale model of a pressurized water reactor rated at 11,500 kw. In my hand I hold a scale model of a fuel-element subassembly for this reactor. This reactor vessel will have an inside diameter of 5 ft and its height over the vessel head will be 15 ft. The main body of the vessel is to be made of 304 stainless-clad carbon steel approximately 4½ in. thick. The design pressure is 2,500 psi and the cold test pressure is 3,750 psi.

The fuel-element subassembly is made up of zircaloy tubes filled with uranium oxide pellets. Thirty-two subassemblies make up the core and provide the heat source for the reactor. The heat is carried away to a steam generator by water at approximately 2,000 psi and 600 deg F. The heat output of the reactor is controlled by moving several neutron-absorbing control rods in and out of the core.

Let's look at the problem of designing and building a control-rod drive mechanism—simply a device for moving a weight up and down. The design is made especially complex because of the necessity for absolutely reliable operation. The requirement is much the same as designing a Swiss watch mechanism to operate in radioactive water at 600 deg F and 2,000-psi pressure. Of course we can't use lubricants because oils and greases are affected by radiation and rapidly become a sticky mass. Further, we cannot tolerate leaks of any kind. And finally, when the mechanism designer has painfully devised an ingenious collection of compatible solutions to these problems, he finds that all his work is wasted because some of his materials will not stand up under the existing environmental conditions. Clearly what is needed in solving this problem is still more hard work, more ingenious devices, and better knowledge of materials.

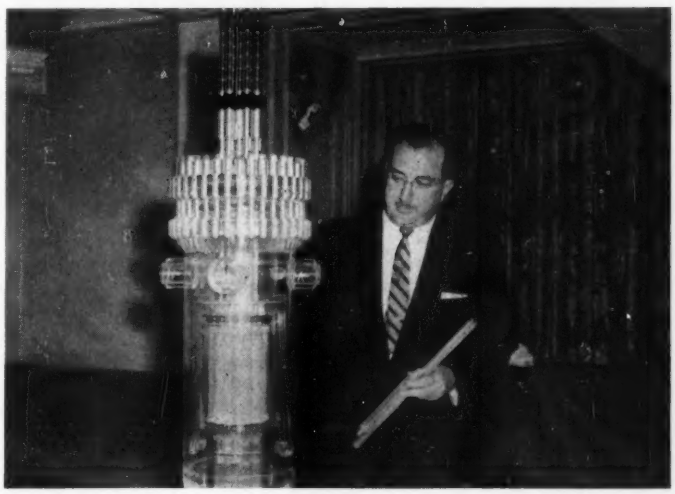
Reduce cost of fuel elements

Another typical problem occurs in the manufacture of fuel elements for the reactor. The use of expensive materials in fuel elements is a tremendous handicap in bringing down prices. Until materials and the processes involved in their manufacture become better known, the high cost of fuel elements is inevitable.

Let's take the case of zirconium, for example. Zirconium is, to many of us, a wonder material in that it resists corrosion. Because of this property and the fact that it does not absorb neutrons readily, zirconium is a popular material for the cladding of fuel elements.

Zirconium ore is cheap. It comes chiefly from the beach sands of Florida, and a large supply is readily available. However, the path from the Florida beach to the reactor is indeed a thorny one, liberally sprinkled with many economic and technological pitfalls. Just to convert the ore to sponge metal, the first of many steps on the pathway to our reactor, entails a cost of about $14.00 per lb. There is however good reason to believe that this cost can be reduced by one-half or more as production capacity is enlarged. Additional steps of refining, remelting, and careful alloying are required to convert the sponge to billet form suitable for rolling, drawing, extrusion, or spinning. These steps can easily add another $10.00 per lb to the cost.

Now we take our zircaloy costing $24.00 per lb to a fabricator to be drawn into tubes and shapes. Heat-



Author C. V. Roseberry stands beside model of 11,500-kw pressurized-water reactor. Prototype has diameter of 5 ft. He holds in his hand a model of one fuel element subassembly, of which 32 are required in reactor core.

transfer problems in a pressurized water reactor are very critical and therefore tube specifications are strict. Because zircaloy is so difficult to work, very few fabricators are willing to tackle the problem and even fewer have been successful in working this material to required specifications.

To make a long story short, we now supply to the fabricator the zircaloy billets and he, in turn, attempts to supply tubing to specification. Average yields vary from 15 to 20 percent, and the fabricator's cost alone has been as high as $20.00 per ft. In addition to the high processing costs, we may be fortunate if 10 to 20 percent of our original material appears in the reactor core. Needless to say, there is ample room for cost reduction in this general area.

It is obvious that to reduce costs here requires one of three solutions. The fuel elements must last for a very long time, or they must be made cheaply, or they must be eliminated completely from reactor design. Many of the tedious steps involved and the high costs associated with the use of zirconium must go, or some more common, more practical material must be substituted. All these approaches are, of course, currently being worked on. Westinghouse, for example, in its PAR Project, is developing a homogeneous type reactor in conjunction with the Pennsylvania Power and Light Company. Here the fuel is in the form of a liquid or slurry, and consequently no solid fuel elements are needed. The seeming advantage in such a reactor is partially lost through increased system complexity. In another one of our projects, in conjunction with the Yankee Atomic Electric Company, we are attempting to substitute good old-fashioned stainless steel for the zirconium in the fuel elements.

Shielding costs too high

Another problem will be of somewhat greater interest to civil engineers. It is a dual problem. First, it involves a structure that must be designed to provide the required degree of radiation shielding. Second, it involves the confinement of all the radioactive vapors that might escape in case of failure of one of the high-pressure components. In its simplest form, a radiation shield consists of a large amount of concrete, lead, or other suitable material, put around a reactor to prevent its radiation from affecting operating personnel. However, the direct application of these materials to the reactor is not possible because of the temperatures involved, and therefore we must incorporate thermal shields, as well as radiation shields, into our design.

These thermal shields, which may consist of many tons of iron, must be cleverly interlaced with many more tons of concrete. We wind up with a very heavy reactor pressure vessel along with its very complicated system of pumps, pipes, heat exchangers, and other equipment—all installed in a vapor-tight structure of considerable magnitude. For this application, the heavier the density of the concrete, the better we like it.

Assuming that we have now adequately protected personnel from the direct radiation of the reactor, there are ways in which the primary coolant or some other part of the plant may produce radioactive air or vapor. This air or vapor must be confined inside the reactor building until it can be properly controlled or disposed of. The potential hazard that this radioactive vapor holds for surrounding population provides a third-party liability insurance problem far greater in magnitude than anything industry has ever previously encountered. For this reason almost all power reactors are confined in a huge vapor shell, cylindrical or spherical in shape.

The design of this shell introduces many problems. Its size and pressure rating are governed by the total volume, temperature, and pressure of the primary coolant used in the reactor system. Should an incident occur that would release this coolant and permit it to flash to steam, the shell must be so designed that it can take the surge in pressure, and it must also be designed against projectiles in the event that any part of the plant becomes a missile.

The vapor shell of a 125,000-kw pressurized-water plant could take the shape of a cylinder lying on its side. The cylinder would be 360 ft long and 60 ft in diameter. It would withstand an internal pressure of 45 psi and be fabricated from 1¾- to 2-in. steel plate.

Overall simplification needed

Thus far we have dealt with the elements of a reactor and the design problems associated with them. Now for a moment let's consider the total reactor. In principle, it is a very simple device. Atomic reaction can be harnessed to generate heat within small metal rods. These rods are then bundled together to produce heat in the quantity desired. There is no smoke, no ashes, no fumes, and no oxygen is required to maintain operation. The metal surface just gets hot and generates heat of its own accord. Heat is removed from the unit by water flowing over the rods.

Control of a reactor is easily accomplished also. By moving a second set of rods through the heat-producing bundle, energy output is manipulated. Such is the principle of a nuclear-powered electric generating station or of a naval propulsion unit. However, when a reactor is thus applied, the overall plant becomes extremely complex. Not only is the reactor itself made more complicated in application, but also its auxiliary components combine into extremely intricate systems. This is not unusual when new concepts are being developed. It is almost to be expected when entering a field overrun with unknowns.

The job immediately at hand is one of simplifying these highly complex systems and engineering a much more practical plant from the standpoint of operation and cost. Simplification must come, not only in the area of the reactor itself, but also in connection with shielding, auxiliary items, and perhaps most important, in the area of civil engineering works. If this new source of energy, so necessary to our future way of life, is to be harnessed economically, then a concentrated effort must be made to reduce cost. Since it is estimated that at least half the cost of an atomic power plant is in the civil engineering field, the civil group has a very important obligation to discharge in the future development of atomic energy. There is a challenge to be faced here—one that cannot be passed on to future generations. It is one that has to be met today.

During the next few months, engineers are going to hear much more about the need for nuclear power development. Great Britain has dedicated its Calder Hall. The Russians are alleged to have several plants about ready for operation. Pressures will be exerted on the Congress to appropriate millions of dollars to speed the development of nuclear plants and to expedite their construction. These pressures will be exerted supposedly to guarantee our world leadership in the development of atomic energy. It is obvious to the straight-thinking person that neither the solution to the problems outlined here, nor leadership in this field, can be legislated or otherwise achieved on a continuing basis without the initiative of private enterprise. That segment of the engineering profession and related industries which civil engineers represent must visualize the full potential of atomic power and recognize the need to come to grips immediately with the problems at hand.

(This article was originally presented by Mr. Roseberry as an address before the Nuclear Energy Luncheon, a feature of the ASCE Pittsburgh Convention which was presided over by Clayton O. Dohrenwend, Chairman of the Executive Committee, Engineering Mechanics Div.

ENGINEERS' NOTEBOOK

A floating breakwater that proved effective

COLIN J. ROBB

Consultant on Preservation of Old Buildings and Monuments, Ballynaminch, Ireland

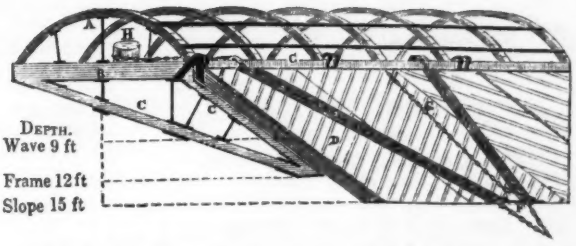


FIG. 1. Breakwater consisting of floating timber frame, braced with iron struts and bars, was tried out by the British Navy just one hundred years ago. It proved effective while it lasted but its mooring cables were soon destroyed by corrosion.

A century ago, in November 1856, a novel floating breakwater was tried out by the British Navy at an exposed base off the coast of County Cork, Ireland. This unusual structure had been designed by an Anglo-American named Reid, an English engineer who had practiced for years in America. His design, made in 1842, was based on the fact that wrecks were effective in breaking up the heaving and troubled waves. This marine structure was depicted in a paper published in *The Civil Engineer and Architect's Journal*, May 1842, from which the accompanying Fig. 1 is reproduced.

Reid's breakwater consisted of a long arched frame, *A*, broken into bays by strong cast-iron strutted arches of wood. The arches were strung together by wrought-iron bars resting on the frame, *B* and *C*, which was supported by under trusses *B*, *C* and *D*. At the back was a sloping herringbone frame, *C*. The breakwater floated with the arched frame in a horizontal position and was anchored back by chains and cables, *E*, *F* and *G*.

The action of this breakwater was based on the principle that the sturdy framing offered buoyant and gentle resistance to the falling wave, which distributed itself in the riding heave in a harmless way.

The breakdown was made in sections, each 30 ft long, and in the thorough test made by the British Navy a century ago, referred to above, it proved its worth. The drawback then was that the mooring cables and chains soon perished in the sea by corrosion. Has this type of marine barrier a future in this age of prestressed concrete and corrosion-resistant metals?

THE READERS WRITE

Right to differ defended

To PRESIDENT LOCKWOOD: Please record my vigorous objection to using CIVIL ENGINEERING as a medium for the dissemination of propaganda for the heterogeneous union known as Engineers and Scientists of America. The article in the October 1956 issue by Mr. Wiersema is a savage blow, with the apparent blessing of the Society, against the many members who by professional conduct, professional example, professional relationship with engineering employees and associates, as well as by public pronouncements, have sought to counter the invidious half-truths of ESA and its ilk.

CHARLES P. SMITH, M. ASCE
Consulting Engineer
Baltimore, Md.

To MR. SMITH: Speaking as a member of the Society rather than as its President, I will say that I personally consider unionization incompatible with professionalism for engineers. The facts are, however, that some of our members think otherwise. And I therefore take no exception to proportional space in our official magazine being used to record the views of this minority, regardless of my own strong disagreement with the sentiments expressed.

It is not quite a fair appraisal to consider that Mr. Wiersema's article, by virtue of its appearance in CIVIL ENGINEERING, has the official blessings of the Society. As a matter of fact, very few of the articles that appear in the magazine are officially endorsed. In the endorsed category would fall, it seems to me, only such Board or membership-approved proclamations or announcements as may appear from time to time.

The more articulate the membership is, the better their President can serve them. You have been articulate, and therefore your letter is appreciated.

MASON G. LOCKWOOD,
President of ASCE
Partner, Lockwood, Andrews & Newman
Houston, Tex.

AMERICAN SOCIETY OF CIVIL ENGINEERS

Jackson Convention

Mid-South Section Host

Heidelberg Hotel **Jackson, Miss.** **February 18–21, 1957**

REGISTRATION

Heidelberg Hotel, main floor, on corridor just off lobby

Sunday, Feb. 17: 3:00 p.m. to 7:00 p.m.

Monday through Wednesday: 8:30 a.m. to 5:30 p.m.

Thursday: 8:30 a.m. to 1:00 p.m.

Registration fee, $5.00 (except ladies and students).

ADVANCE INFORMATION ON ATTENDANCE

To help in planning adequate facilities for the Jackson Convention, the Convention Committee would appreciate your help in letting us know if you plan to attend. Please fill out the coupon on page 146 and mail to H. C. McGee, Registration Chairman, P. O. Drawer 2131, Jackson 5, Miss. This is not a preregistration, and payments for events are not required at this time. These can be taken care of when you register. Thank you for your cooperation.

ROOMS FOR STUDENTS

Accommodations are being arranged for students at nominal rates at the Jackson YMCA, Millsaps College, and Mississippi College. Advance information may be obtained from Mr. Boyce M. Biggers, Chairman, Hotel Committee, c/o Spain, Campbell & Biggers, Deposit Guaranty Building, Jackson, Miss.

HOTEL ACCOMMODATIONS

Headquarters for the Jackson Convention will be the Heidelberg Hotel in downtown Jackson. Some of the Convention meetings will be held in the Edwards Hotel about one block from Convention Headquarters. Within a two-block radius are the Robert E. Lee and the Walthall Hotels. Arrangements have been made to accommodate Convention visitors at all the above-listed hotels in the order that reservation requests are received. Send in your request early to the hotel of your choice. A special request form is provided for your convenience on page 149.

AUTHORS' BREAKFASTS

8:00 a.m. Green Room, Heidelberg Hotel

Monday, Tuesday, Wednesday, Thursday

Briefing sessions for speakers, discussers, and program officials for each day will take place at a breakfast meeting on the morning of that day. Attendance is by invitation only.

Presiding: **Monday and Wednesday:**
WILLARD J. TURNBULL, Chairman, Technical Program Committee

Tuesday and Thursday:
EUGENE P. FORTSON, Member Technical Program Committee

MONDAY MORNING

FEB. 18

Pipeline Division

9:30 a.m. Club Room, Edwards Hotel

Presiding: Eldon V. Hunt, Chairman, Exec. Committee, Pipeline Div.

9:30 Prediction of Surge Pressures in Oil Pipelines
ROBERT D. KERSTEN, A.M. ASCE, Research Engr., Carter Oil Co., Tulsa, Okla.

10:00 Fundamental Fluid Mechanics for Oil Pipelines
FRANK E. HANGS, Chief Design Engr., Pipeline Technologists, Inc., Houston, Tex.

10:30 Artery for Alaska (movie with sound) by Williams Brothers Co., Tulsa, Okla.

11:00 Flow of Natural Gas in Pipelines
WILLIAM T. IVEY, M. ASCE, Statistician and Planning Engr., Southern Natural Gas Co., Birmingham, Ala.

Power Division

9:30 a.m. Rose Room, Heidelberg Hotel

Presiding: E. S. Harrison, M. ASCE, Asst. Chief Engr., Georgia Power Co., Atlanta, Ga.

9:30 The Peixoto Hydroelectric Development in Brazil
J. F. PETT, A.M. ASCE, Asst. Hydraulic Engr., International Div., Ebasco Services, Inc., New York, N. Y.
R. OLAFSEN, M. ASCE, Hydraulic Engr., Ebasco Services, Inc., New York, N. Y.

10:15 The Selection of Site and Type of Structure—Hartwell Dam
C. F. TRAINOR, M. ASCE, Chief Engr., Savannah Dist., Corps of Engineers, Savannah, Ga.

Discussion:

R. R. LUNOE, Savannah Dist., Corps of Engineers, Savannah, Ga.

11:00 Warrior River Development
R. S. WOODRUFF, A.M. ASCE, Engr., Alabama Power Co., Birmingham, Ala.

Sanitary Engineering Division

9:30 a.m. Coronet Room, Edwards Hotel

A Broad Look at the Field of Sanitary Engineering

Presiding: Ray E. Lawrence, Member, Exec. Committee, Sanitary Eng. Div.

9:30 Sanitary Engineering Horizons

10:00 Sanitary Engineering Education

DANIEL A. OKUN, A.M. ASCE, Head, Dept. of Sanitary Eng., School of Public Health, Univ. of North Carolina, Chapel Hill, N. C.

10:30 Sanitary Engineering Administration—Panel Discussion

DAVID LEE, Sanitary Engr., State Dept. of Health, Tallahassee, Fla.

KENNETH WATSON, Chemical Engr., General Electric Co., Schenectady, N. Y.

ARTHUR N. BECK, M. ASCE, Director, Bur. of Sanitation, Alabama Dept. of Public Health, Montgomery, Ala.

Waterways and Harbors Division

9:30 a.m. Roof, Heidelberg Hotel

Presiding: Lewis C. Coxe, Capt., CEC, U. S. Navy; Chairman, Exec. Committee, Waterways and Harbors Div.; U. S. Naval Academy, Annapolis.

9:30 Operation of Missouri River Main-Stem Reservoirs

R. J. PAFFORD, JR., Chief, Reservoir Control Center, Missouri River Div., Corps of Engineers, Omaha, Nebr.

10:00 Development and Application of Improved Techniques and Equipment in the Telemetering of Hydrologic Data

FRANCIS P. HANES, Electronics Engr., Waterways Experiment Sta., Corps of Engineers, Vicksburg, Miss.

10:30 Application of Differential Analyses and Digital Computers to Hydraulic Problems

EDWARD A. LAWLER, Hydraulic Engr., Ohio River Div., Corps of Engineers, Cincinnati, Ohio.

FRANK V. DRUML, Hydraulic Engr., Louisville Dist., Corps of Engineers, Louisville, Ky.

11:00 Flood Control Works for Protection of Mississippi-Yazoo Delta

CHARLES KENNETH LITTLE, Civil Engr., Vicksburg Dist., Corps of Engineers, Vicksburg, Miss.

WATERWAYS AND HARBORS AND HYDRAULICS DIVISIONS LUNCHEON

Monday, Feb. 18

12:15 p.m. Roof, Heidelberg Hotel

Presiding: Lewis C. Coxe, Capt., CEC, U. S. Navy; Chairman, Exec. Committee, Waterways and Harbors Div.; U. S. Naval Academy, Annapolis.

Speaker: JOHN R. HARDIN, Maj. Gen., U.S.A.; M. ASCE; Pres., Mississippi River Commission, and Div. Engr., Lower Mississippi Valley Div., Corps of Engineers, Vicksburg, Miss.

Subject: Evaluation of the Flood Control Plan for the Lower Mississippi Valley.

Tickets for this event must be purchased before 10:00 a.m., Monday, Feb. 18. Per plate, $2.50; students, $1.00.

MONDAY AFTERNOON

FEB. 18

Hydraulics Division

2:00 p.m. Rose Room, Heidelberg Hotel

Aerated Flow Research

Sponsored by Committee on Research

Presiding: Harold M. Martin, Vice-Chairman, Exec. Committee, Hydraulics Div., and Head, Hydraulics Lab., U. S. Bur. of Reclamation, Denver.

2:00 Introductory Remarks

FRANK B. CAMPBELL, M. ASCE, Chairman, Committee on Research, Hydraulics Div., and Chief, Hydraulic Analysis Bureau, Hydraulics Div., Waterways Experiment Sta., Corps of Engineers, Vicksburg, Miss.

2:15 Experiments on Self-Aerated Flow in Open Channels

LORENZ G. STRAUB, M. ASCE, Director, St. Anthony Falls Hydraulic Lab., Univ. of Minnesota, Minneapolis, Minn.

ALVIN G. ANDERSON, A.M. ASCE, Asst. Prof., Hydraulics, St. Anthony Falls Hydraulic Lab., Univ. of Minnesota, Minneapolis, Minn.

3:00 Entrainment of Air by Flowing Water in Circular Conduits with Downgrade Slopes

JOSEPH C. KENT, J.M. ASCE, Instructor, Civil Eng., Univ. of Washington, Seattle, Wash.

3:45 Report of Task Force on Aerated Flow in Open Channels

WARREN W. DELAPP, A.M. ASCE, Assoc. Prof., Civil Eng., Univ. of Colorado, Boulder, Colo.

POWER DIVISION FIELD TRIP

Monday, Feb. 18

3:00 p.m.

Trip: Visit to Rex I. Brown Steam Works Plant, operated by the Mississippi Power and Light Company. It is one of the first outdoor power plants ever constructed and operated in this country. Steam is generated with natural gas, with oil stand-by.

Transportation: By bus.

Departure: 3:00 p.m. from Heidelberg Hotel.

Return: 5:00 p.m. to Heidelberg Hotel.

Cost: $0.50.

Registration: At Convention registration desk no later than 10:00 a.m., Monday, Feb. 18.

Pipeline Division

2:00 p.m. Club Room, Edwards Hotel

Presiding: Robert E. Kling, Chairman, Program Committee, Pipeline Div., Site Oil Co., St. Louis, Mo.

2:00 Pipeline River Crossings

LEO M. ODOM, M. ASCE, Consulting Engr., Baton Rouge, La.

2:30 Missouri River Crossing at Plattsmouth, Nebr.

Movie (16 mm with sound) by Northern Natural Gas
Commentary: C. A. REYNOLDS and A. C. VAN TASSEL, Pittsburgh-Des Moines Steel Co.; and WILDER KENAN, M. ASCE, Matthews and Kenan, San Antonio, Tex.

3:00 Some Observations on Stresses in Large-Diameter Pipelines

GEORGE MCCLURE, Asst. Chief, Applied Mechanics Div., Battelle Memorial Inst., Columbus, Ohio.

3:30 Hydrostatic Testing of Pipelines

LEON E. BROOKS, Chief Engr., Williams Pressure Service Co., Ltd., Shreveport, La.

Sanitary Engineering Division

2:00 p.m. Coronet Room, Edwards Hotel

Wastes Disposal

Presiding: Robert H. Young, Member, Program Committee, Sanitary Eng. Div., and Consulting Engineer, Jackson, Miss.

2:00 Sewage Treatment by Raw Sewage Lagoons

W. W. TOWNE, M. ASCE, Chief, Water Pollution Control, Water Supply and Pollution Control Field, U. S. Public Health Service,

SURVEYING AND MAPPING DIVISION FIELD TRIP

3:00 p.m. Monday, Feb. 18

Trip: Visit to the Southern Division Office of the consulting engineering firm of Michael Baker, Jr., Inc. In addition to extensive highway design work, this office is engaged in a complete photogrammetric mapping program. Opportunities will be afforded for observing the latest type of stereoplotting equipment and correlation of photogrammetric processes with highway location and design.

Transportation: By bus or private automobile.

Departure: 3:00 p.m. from Heidelberg Hotel.

Return: 5:00 p.m. to Heidelberg Hotel.

Cost: No charge.

Registration: At Convention registration desk no later than 10:00 a.m., Monday, Feb. 18.

Robert A. Taft Sanitary Eng. Center, Cincinnati, Ohio.

2:45 Sanitary Sewage Disposal for Subdivisions

PAUL W. RICHARDS, M. ASCE, Engr., U. S. Public Health Service, Atlanta, Ga.

3:30 The USPHS Stream Pollution Abatement Program

LEWIS A. YOUNG, M. ASCE, Asst. Regional Engr., Chief, Water Supply and Water Pollution Control Activities, U. S. Public Health Service, Atlanta, Ga.

Surveying and Mapping Division

2:00 p.m. Bamboo Room, Edwards Hotel

Presiding: Milton O. Schmidt, Member, Exec. Committee, Surveying and Mapping Div.; Prof., Civil Eng., Univ. of Illinois, Urbana.

2:00 A Meteorological Method for Determining Differences in Elevation

L. V. TORALBALLA, Assoc. Prof. of Mathematics, New York Univ., New York, N. Y.

2:30 Highway Location Surveys

JOHN A. ROBISON, M. ASCE, Supervising Engr., Michael Baker, Jr., Inc., Jackson, Miss.

Waterways and Harbors Division

2:00 p.m. Roof, Heidelberg Hotel

Presiding: Lewis C. Coxe, Capt., CEC, U. S. Navy; Chairman, Exec. Committee, Waterways and Harbors Div.; U. S. Naval Academy, Annapolis.

2:00 Mississippi River Gulf Outlet

WILLIAM H. LEWIS, Col., CE, U.S.A., Dist. Engr., New Orleans Dist., Corps of Engineers, New Orleans, La.
L. C. BRUNE, Engineer, New Orleans Dist., Corps of Engineers; New Orleans, La.

2:30 Mississippi River—Baton Rouge to Gulf

OTIS M. JERNIGAN, M. ASCE, Asst. Chief, Operations Div., New Orleans Dist., Corps of Engineers, New Orleans, La.

3:00 Mobile Harbor and Ship Channel

HAROLD E. BISBORT, Col., CE, U.S.A., M. ASCE, Dist. Engr., Mobile Dist., Corps of Engineers, Mobile, Ala.

3:30 Effect of Navigable Waterways on Industrial Development of the South

DEWITT L. PYBURN, M. ASCE, Consulting Engr., Baton Rouge, La.

PIPELINE DIVISION DINNER MEETING

Monday, Feb. 18

7:30 p.m.–9:30 p.m. Club Room, Edwards Hotel

Presiding: JOSEPH B. SPANGLER, Secretary, Exec. Committee, Pipeline Div., and Chief Statistical Engr., Fish Northwest Constructors, Inc., Houston, Tex.

Speaker: GEORGE D. HARTLEY, A.M. ASCE, Construction Engr., Arabian American Oil Co., Uthmaniyah, Dhahran, Saudi Arabia.

Subject: Arabian Pipelines—Men, Materials and Equipment (with 35-mm Kodachromes).

Tickets for this event must be purchased before 11:00 a.m., Monday, Feb. 18. Price per plate, $3.50; students, $2.00.

ICEBREAKER PARTY

Monday, Feb. 18

5:00 to 6:30 p.m. Victory Room, Heidelberg Hotel

Here is the first opportunity for you and your wife to get together with other Convention members and their wives. Come and enjoy a pleasant social hour. Plan your own dinner party with your friends following the party.

Tickets obtainable at the Convention registration desk not later than 11:00 a.m., Monday, Feb. 18. Per person, $2.00.

MONDAY EVENING ENTERTAINMENT

Monday, Feb. 18

Provine High School Auditorium

The Jackson Symphony Orchestra will present a concert on Monday evening at the Provine High School Auditorium. Join other members of the Convention in an evening of good music.

Tickets will be on sale at the Convention registration desk. Price, $2.20, students, $1.10. Transportation by local bus or taxi. Inquire at the registration desk as to how to get there.

TUESDAY MORNING FEB. 19

Highway and Surveying and Mapping Divisions, Joint Session

9:30 a.m. Roof, Heidelberg Hotel

Photogrammetric Mapping

Presiding: Milton O. Schmidt, Member, Exec. Committee, Surveying and Mapping Div., and Prof., Civil Eng., Univ. of Illinois, Urbana.

9:30 Use of Photogrammetric Consultants to Expedite Highway Design

JOHN G. LADD, Col., U.S.A. Ret., Executive Secretary, Assoc. of Prof. Photogrammetrists, Washington, D. C.

10:15 Research and New Developments in Photogrammetry

CHARLES L. MILLER, J.M. ASCE, Asst. Prof. of Surveying, Mass. Inst. of Technology, Cambridge, Mass.

11:00 Making Full Use of Photogrammetry in Highway Design

AUBREY H. DA SANTOS, Photogrammetric Engr., State Highway Dept. of Georgia, Atlanta, Ga.

Hydraulics Division

9:30 a.m. Rose Room, Heidelberg Hotel

Tidal Hydraulics

Sponsored by Committee on Tidal Hydraulics

Presiding: Harold M. Martin, Vice-Chairman, Exec. Committee, Hydraulics Div., and Head, Hydraulics Lab., U. S. Bur. of Reclamation, Denver; and C. F. Wicker, Past Chairman, Committee on Tidal Hydraulics, Hydraulics Div., and Chief, Eng. Div., Philadelphia Dist., Corps of Engineers, U.S.A., Philadelphia, Pa.

9:30 The Relationship Between Tidal Bodies and Fresh Water Aquifers

JACK B. GRAHAM, Partner, Leggette, Brashears & Graham, Consulting Geologists, New York, N. Y.

10:15 Occurrence and Control of Salt Intrusion Through Navigation Locks

GORDON L. LONG, A.M. ASCE, Supervising Hydraulic Engr.; ROBERT G. EILAND, Senior Hydraulic Engr.; LAWRENCE A. MULLNIX, J.M. ASCE, Assoc. Hydraulic Engr., all of Dept. of Water Resources, State of California, Sacramento.

11:00 Wind Field and Surface and Bottom Stresses in Experiments on Wind Tides

GARBIS H. KEULEGAN, Fluid Mechanics Sect., U. S. Bureau of Standards, Washington, D. C.

Sanitary Engineering Division

9:30 a.m. Coronet Room, Edwards Hotel

Water Resources

Presiding: Ray E. Lawrence, Member, Exec. Committee, Sanitary Eng. Div.

9:30 Surface Water Resources

J. V. B. WELLS, M. ASCE, Chief, Surface Water Branch, Water Resources Div., U. S. Geological Survey, Washington, D. C.

Discussion

I. E. ANDERSON, M. ASCE, Dist. Engr., Water Resources Div., U. S. Geological Survey, Jackson, Miss.

10:30 Ground Water Resources

ALBERT G. FIEDLER, M. ASCE, Asst. Chief, Ground Water Branch, Water Resources Div., U. S. Geological Survey, Washington, D. C.

Discussion

JOE LANG, Dist. Geologist, Water Resources Div., U. S. Geological Survey, Jackson, Miss.

Structural Division

9:30 a.m. Club Room, Edwards Hotel

Presiding: Leo H. Corning, Member, Exec. Committee, Structural Div., and Director of Promotion, Portland Cement Assn., Chicago, Ill.

9:30 Applications of AASHO Specifications to Highway Bridge Design

E. L. ERICKSON, Chief, Bridge Branch, Bureau of Public Roads, Washington, D. C.

10:15 Earth Pressures on Abutments and Retaining Walls

R. B. PECK, M. ASCE, Research Prof., Soil Mechanics, Univ. of Illinois, Urbana, Ill.

H. O. IRELAND, A.M. ASCE, Research Assoc., Dept. of Civil Eng., Univ. of Illinois, Urbana, Ill.

11:00 Committee Report on Factors of Safety

O. G. JULIAN, M. ASCE, Chairman, Committee on Factors of Safety, and Head, Structural Div., Jackson & Moreland, Boston, Mass.

PIPELINE DIVISION FIELD TRIP

Tuesday Feb. 19

11:45 a.m.

Trip: Visit to the Mid-Valley Pipeline crossing of the Mississippi River at Mayersville, Miss. This pipeline, owned jointly by the Sohio Oil Company and the Sun Oil Company, originates in Texas and goes to Ohio and western Pennsylvania. Visitors on this trip will be able to see and inspect the tank farm, pumping station, and the 1¼-million-dollar crossing. Personnel of Mid-Valley will act as hosts and guides for the visitors.

Transportation: By bus.

Departure: 11:45 a.m. from Heidelberg Hotel.

Return: 6:00 p.m. to Heidelberg Hotel.

Cost: $3.50.

Registration: At Convention registration desk no later than 4:00 p.m., Monday, Feb. 18.

GOVERNOR'S LUNCHEON

Tuesday, Feb. 19

12:15 p.m. **Victory Room, Heidelberg Hotel**

Presiding: MASON G. LOCKWOOD, President, ASCE.

Toastmaster: SYDNEY W. CHANDLER, M. ASCE, Convention Chairman.

Speaker: HON. J. P. COLEMAN, Governor, State of Mississippi.

All members, their ladies and guests, and friends of ASCE are invited to attend. Tickets for this event must be purchased before 6:00 p.m. on Monday, Feb. 18. Per plate, $2.50; students, $1.00.

TUESDAY AFTERNOON

FEB. 19

Highway Division

2:30 p.m. **Roof, Heidelberg Hotel**

Current Problems Relating to Control of Access

Presiding: J. Paul Buckley, Member, Exec. Committee, Highway Div., and Chief Engr., Highway Div., Automotive Safety Foundation, Washington, D. C.

2:30 Interstate Highway Standards

CONRAD H. LANG, M. ASCE, Chief Engr., New York State Thruway Authority, Albany, N. Y.

3:00 Special Operation Problems on Controlled Access Facilities

CHARLES M. NOBLE, M. ASCE, Chief Engr., New Jersey Turnpike Authority, New Brunswick, N. J.

3:20 Location Requirements to Obtain Full Benefit from Freeways

B. P. MCWHORTER, M. ASCE, Div. Engr., Div. 3, U. S. Bureau of Public Roads, Atlanta, Ga.

3:40 Benefits of Freeways

TERRY J. OWENS, M. ASCE, Urban Highway Engr., Automotive Safety Foundation, Washington, D. C.

Irrigation and Drainage Division

2:30 p.m. Coronet Room, Edwards Hotel

Drainage Practices in Humid Areas

2.30 Transport of Sediment in Helical-Corrugated Pipe

M. L. ALBERTSON, M. ASCE, Prof. of Civil Eng., and Head, Fluid Mechanics Research; A. R. CHAMBERLAIN, School of Civil Eng.; and A. R. GARDE, School of Civil Eng.; all Colorado A. & M. College, Fort Collins, Colo.

3:15 Plans for Drainage in Mississippi Delta, in Cooperation with Corps of Engineers

LOUIS M. HERNDON, Drainage Engr., Soil Conservation Service, USDA, Fort Worth, Tex.

4:00 Development of Large Bodies of Mississippi Delta Lands by Irrigation, Drainage, Phenology

HARRY RUBEY, M. ASCE, Prof. Emeritus of Civil Eng., Univ. of Missouri, Columbia, Mo.

Hydraulics Division

2:30 p.m. Rose Room, Heidelberg Hotel

Sponsored by Committee on Design

Presiding: Harold M. Martin, Vice-Chairman, Exec. Committee, Hydraulics Div., and Head, Hydraulics Lab., U. S. Bureau of Reclamation, Denver.

2:30 Introductory Remarks: Activities of the Hydraulics Division

J. B. TIFFANY, M. ASCE, Past Chairman and Secretary, Exec. Committee; Asst. Director, Waterways Experiment Station, CE, USA, Vicksburg, Miss.

2:45 Flow Through Porous Media as in a Trickling Filter

W. E. HOWLAND, A.M. ASCE, Prof. of Civil Eng., Purdue Univ., West Lafayette, Ind.

3:30 Modern Concept of Pipe Resistance as Related to Exponential Formulas and Equivalent Pipes

WALTER L. MOORE, A.M. ASCE, Prof. of Civil Eng., Univ. of Texas, Austin, Tex.

4:15 Exploratory Investigation of Pipe Culvert Inlets

JOHN L. FRENCH, A.M. ASCE, Hydraulics Engr., National Bur. of Standards, Washington, D. C.

HERBERT G. BOSSY, M. ASCE, Head, Hydraulics Sect., Hydraulics Branch, Research Div., U. S. Bur. of Public Roads, Washington, D. C.

Soil Mechanics and Foundations Division

2:30 p.m. Crown Room, Edwards Hotel

Presiding: Ralph E. Fadum, M. ASCE, Head, Dept. of Civil Eng., North Carolina State College, Raleigh.

2:30 Lower Mississippi Valley Geology and Its Significance to Engineers

C. R. KOLB, Chief, Geology Branch; and W. G. SHOCKLEY, M. ASCE, Chief, Embankment and Foundation Branch; both, Soils Div., Waterways Experiment Sta., Corps of Engineers, Vicksburg, Miss.

Discussion

3:15 Underseepage and Its Control

W. J. TURNBULL, M. ASCE, Chief, Soils Div.; and C. I. MANSUR, M. ASCE, Asst. Chief, Embankment and Foundation Branch, Soils Div.; both, Waterways Experiment Sta., Corps of Engineers, Vicksburg, Miss.

Discussion

4:00 Dewatering Excavation for Low Sill Structure, Old River, La.

C. I. MANSUR, M. ASCE, Asst. Chief, Embankment and Foundation Branch; and R. I. KAUFMAN, J.M. ASCE, Chief, Design and Analytical Section, Embankment and Foundation Branch; both, Soils Div., Waterways Experiment Sta., Corps of Engineers, Vicksburg, Miss.

Discussion

Structural Division

2:30 p.m. Club Room, Edwards Hotel

Presiding: George S. Vincent, Member, Exec. Committee, Structural Div., and Principal Bridge Design Engr., Physical Research Branch, U. S. Bur. of Public Roads, Washington, D. C.

2:30 Vehicle Loads and Highway Bridge Design

STEWART MITCHELL, M. ASCE, Consulting Engineer, Sacramento, Calif.

GERALD BORRMANN, J.M. ASCE, Engr., Standard Oil of California, San Francisco.

3:00 Load Factors for Prestressed Concrete Bridges

T. Y. LIN, M. ASCE, Chairman, Committee on Bridge Loadings, and Prof. of Civil Eng., Univ. of California, Berkeley.

3:30 Highway Bridge Loading Frequencies Based on Chance Grouping of Heavy Vehicles in Traffic

HENSON K. STEPHENSON, M. ASCE, Prof., Dept. of Structural and Research Eng., Texas A. & M. College, College Station.

4:00 Application of Digital Computers to Bridge Design

C. F. SCHEFFEY, J.M. ASCE, Prof., Dept. of Civil Eng., Univ. of California, Berkeley.

TUESDAY EVENING ENTERTAINMENT

Tuesday, Feb. 19

8:00 p.m. — **Jackson Central High School Auditorium**

A delightful evening's entertainment will be presented by students of Belhaven and Millsaps Colleges. Songs, piano selections, and one-act plays in a light and humorous vein will be the order of the evening. Members, ladies, and friends of ASCE are invited to come out and see these talented young people.

Tickets may be obtained until 3:00 p.m., Tuesday, Feb. 19, at the Convention registration desk at $1.00 per person, $0.50 for students. Jackson Central High School is across the street from the Robert E. Lee Hotel, within easy walking distance of Convention Headquarters.

WEDNESDAY MORNING

FEB. 20

Welcome Session

9:00 a.m. Victory Room, Heidelberg Hotel

Presiding: Mason G. Lockwood, President, ASCE.

9:00 Welcome by Mid-South Section
R. W. SAUER, President of Section.

9:05 Welcome to Jackson
HON. ALAN C. THOMPSON, Mayor of the City of Jackson, Miss.

9:15 Response
MASON G. LOCKWOOD, President, ASCE; Partner, Lockwood, Andrews & Newnam, Houston, Tex.

Department of Conditions of Practice

9:30 a.m. Victory Room, Heidelberg Hotel

Presiding: Glenn W. Holcomb, Vice-President, Zone IV; Chairman, Dept. of Conditions of Practice; Prof. and Chairman, Dept. of Civil Eng., Oregon State College, Corvallis.

Panel on How to Attract Suitable High School Students to the Civil Engineering Profession

Sponsored by Committee on Engineering Education

Moderator: Elmer K. Timby, M. ASCE, Partner, Howard, Needles, Tammen and Bergendoff, New York, N. Y.

The Situation with Respect to the Need for Instruction in Science and Mathematics in Secondary Schools

DR. DONALD B. ANDERSON, Program Director for Education in Sciences, National Science Foundation, Washington, D. C.

Counseling at High School Level

MERCEL J. SHELTON, M. ASCE, Deputy Director, California State Div. of Water Resources, Sacramento.

Why I Chose Civil Engineering as a Career

WILLIAM J. FLATHAU, J.M. ASCE, Engr., Hydrodynamics Branch, Hydraulics Div., Waterways Experiment Sta., Corps of Engineers, Vicksburg, Miss.

Civil Engineering as a Career

LEE H. JOHNSON, M. ASCE, Dean, College of Eng., Tulane Univ., New Orleans, La.

The Basic Approach to Engineering Vocational Guidance

J. F. REDUS, JR., A.M. ASCE, Engr., Flexible Pavement Branch, Soils Div., Waterways Experiment Sta., Corps of Engineers, Vicksburg, Miss.

Discussion

What You Can Take Back to Your Section to Assist in Getting High School Students Interested in Civil Engineering, and Summation

ELMER K. TIMBY, M. ASCE, Partner, Howard, Needles, Tammen and Bergendoff, New York, N. Y.

Hydraulics Division

9:30 a.m. Rose Room, Heidelberg Hotel

Sponsored by Committee on Sedimentation

Presiding: Harold M. Martin, Vice-Chairman, Exec. Committee, Hydraulics Div., and Head, Hydraulics Lab., U. S. Bur. of Reclamation, Denver, Colo.

Co-Chairman: F. H. Larson, Chairman, Committee on Sedimentation, Hydraulics Div., and Head, Eng. & Watershed Planning Unit, Soil Conservation Service, Upper Darby, Pa.

9:30 Introductory Remarks
ALVIN G. ANDERSON, A.M. ASCE, Member, Committee on Sedimentation, Hydraulics Div., and Asst. Prof. of Hydraulics, Univ. of Minnesota, Minneapolis.

9:45 Aggradation and Degradation Observations at Fort Randall Reservoir
ALFRED S. HARRISON, J.M. ASCE, Sup. Hydraulic Engr., Corps of Engineers, Omaha Dist., Omaha, Neb.
ROBERT H. LIVESAY, Corps of Engineers, Omaha Dist., Omaha, Neb.

10:15 The Systematic Occurrence of Sand Waves on the Beds of Alluvial Rivers—Their Possible Significance with Respect to Friction or Resistance to Flow
WALTER C. CAREY, M. ASCE, Engr., New Orleans Dist., Corps of Engineers, New Orleans, La.
DEAN KELLER, New Orleans Dist., Corps of Engineers, New Orleans, La.

10:45 Sedimentation Studies by Soil Conservation Service in Western Gulf States
CHARLES M. MOORE, A.M. ASCE, Head, Design Sect., Eng. and Watershed Planning, Soil Conservation Service, Fort Worth, Tex.
GRAHAM W. RENFRO, Soil Conservation Service, Forth Worth, Tex.

11:15 Resistance of Sediment-Laden Streams
Vito A. Vanoni, M. ASCE, Prof. of Hydraulics, Calif. Inst. of Technology, Pasadena, Calif.

Students' Session

9:00 a.m. Roof, Heidelberg Hotel

Student Papers

Sponsored by Mid-South Section

It is customary in Mid-South Section meetings to have three student papers, one from each of the Student Chapters in the Mid-South area. The three papers are judged, and $30, $20, and $10 prizes provided by the Trippier Foundation, are awarded to the students. This is a typical student session as practiced in the Mid-South Section.

Presiding: Eugene F. Bespalow, Former Contact Member, Miss. State College Student Chapter; Past President, Mid-South Section; Vice-President and Chief Engr., Choctaw, Inc., Memphis, Tenn.

9:00 Paper, Univ. of Arkansas Student Chapter

9:40 Paper, Univ. of Mississippi Student Chapter

10:20 Paper, Miss. State College Student Chapter

11:00 Reorganization of Student Chapter Groups
RAY K. CHALFANT, JR., A.M. ASCE, Member, Committee on Student Chapters, and Structural Engr., Prestressed Concrete of Georgia, Inc., Atlanta.

STRUCTURAL AND SOIL MECHANICS AND FOUNDATIONS DIV. LUNCHEON

Wednesday, Feb. 20

12:15 p.m. Crown Room, Edwards Hotel

Tickets for this event must be purchased before 6:00 p.m., Tuesday, Feb. 19. Per plate, $2.50; students, $1.00.

WEDNESDAY AFTERNOON

FEB. 20

Department of Conditions of Practice

2:00 p.m. Victory Room, Heidelberg Hotel

Symposium on Recruitment of Graduating Engineers

Presiding: Norman R. Moore, Vice-President, Zone III, and Vice-Chairman, Dept. of Conditions of Practice.

2:00 From Standpoint of Consulting Engineers

WAYNE F. PALMER, M. ASCE, President, Palmer & Baker, Inc., Mobile, Ala.

2:30 From Standpoint of Industry

ROY T. SESSUMS, M. ASCE, Asst. to Vice-President and Eng. Coordinator, Freeport Sulphur Co., New Orleans, La.

3:00 From Standpoint of State Highway Department

REX M. WHITTON, M. ASCE, Chief Engr., Missouri State Highway Commission, Jefferson City, Mo., and President, American Assoc. of State Highway Officials.

3:30 From Standpoint of Corps of Engineers

S. R. HANMER, Col., Corps of Engineers, U.S.A., Asst. Chief of Engineers for Personnel, Washington, D. C.

Highway Division

2:30 p.m. Roof, Heidelberg Hotel

Management and Manpower Problems in the Expanded Highway Program

Presiding: B. T. Collier, Chairman, Program Committee, Highway Div., and State Aid Engr., State Highway Dept., Jackson, Miss.

2:40 The City's Place in the Expanded Highway Program

GLEN C. RICHARDS, Commissioner of Public Works, City of Detroit, Mich.

ALFRED BERARDUCCI, Expressway Engr., City of Detroit, Mich.

3:00 Importance of Good County Management

LEE B. BRANDON, M. ASCE, County Engr., Lauderdale County, Meridian, Miss.

3:20 The Use of Technicians in Highway Engineering

SCOTT H. LATHROP, A.M. ASCE, California Div. of Highways, Sacramento, Calif.

3:40 Manpower Problems in the Highway Program

CARL E. FRITTS, M. ASCE, Vice-President in Charge of Eng., Automotive Safety Foundation, Washington, D. C.

Hydraulics Division

2:00 p.m. Rose Room, Heidelberg Hotel

Hydraulic Research for Large Dams

Sponsored by Committee on Research

Presiding: Harold M. Martin, Vice-Chairman, Exec. Committee, Hydraulics Div., and Head, Hydraulics Lab., U. S. Bur. of Reclamation, Denver.

Co-Chairman: Frank B. Campbell, Chairman, Committee on Research, Hydraulics Div., and Chief, Hydraulic Analysis Branch, Hydraulics Div., Waterways Experiment Sta., Corps of Engineers, Vicksburg, Miss.

2:00 Laboratory Investigation of Spillways

FREDERICK R. BROWN, M. ASCE, Chief, Hydrodynamics Branch, Hydraulics Div., Waterways Exp. Sta., Vicksburg.

2:30 Laboratory Investigations of Outlet Works

THOMAS E. MURPHY, M. ASCE, Chief, Structures Sect., Hydrodynamics Branch, Hydraulics Div., Waterways Exp. Sta., Vicksburg.

3:00 Field Investigations of Spillways and Outlet Works

BENSON GUYTON, A.M. ASCE, Chief, Prototype Sect., Hydraulic Analysis Branch, Hydraulics Div., Waterways Exp. Sta., Vicksburg.

3:30 Hydraulic Laboratory and Field Investigations

REX A. ELDER, M. ASCE, Head, Hydraulic Laboratory, Tennessee Valley Authority, Norris, Tenn.

Irrigation and Drainage Division

2:00 p.m. Coronet Room, Edwards Hotel

Sprinkler Irrigation in Humid Areas

2:00 Irrigation in New Jersey

ROBERT L. HARDMAN, A.M. ASCE, Supervising Engr., New Jersey Div. of Water Policy and Supply, Trenton, N. J.

2:45 Important Factors in Design of Sprinkler Irrigation Systems

GUY O. WOODWARD, Sprinkler Irrigation Assn., Salt Lake City, Utah.

3:30 Irrigating in a Humid Area

E. A. KIMBROUGH, Agricultural Engr., Miss. State College, State College, Miss.

Soil Mechanics and Foundations Division

2:00 p.m. Crown Room, Edwards Hotel

Symposium on Products of Rock Weathering

Presiding: Ralph B. Peck, M. ASCE, Research Prof., Soil Mechanics, Univ. of Illinois, Urbana, Ill.

2:00 Soil and Foundation Conditions in the Piedmont and Blue Ridge Regions

G. F. SOWERS, A.M. ASCE, Prof. of Civil Eng., Georgia Inst. of Technology, Atlanta, Ga.

Discussion

2:45 Physical Properties of Some Residual Sandstone Soils

T. H. THORNBURN, A.M. ASCE, Research Prof. of Civil Eng., Univ. of Illinois, Urbana, Ill.

Discussion

3:00 Physical Characteristics of Some Tropical Residual Soils

D. U. DEERE, A.M. ASCE, Assoc. Prof. of Civil Eng. and Geology, Univ. of Illinois, Urbana, Ill.

Discussion

Structural Division

2:00 p.m. Club Room, Edwards Hotel

Presiding: John E. Rinne, Member, Exec. Committee, Structural Div., and Engr., Standard Oil Co. of Calif., San Francisco, Calif.

2:00 The Vibration of Simple-Span Highway Bridges

JOHN M. BIGGS, A.M. ASCE, Assoc. Prof., Structural Eng.; H. S. SUER, J.M. ASCE, Senior Structural Research Engr.; and J. M. LOUW, Research Asst.; all, Mass. Inst. of Technology, Cambridge, Mass.

2:45 Distribution of Loads on Bridge Decks

A. M. LOUNT, of T. O. Lazarides, Lount & Partners, Toronto, Ontario, Canada.

3:30 Repetitive Loads on Prestressed Concrete Bridges

E. C. ECKBERG, Prof., Dept. of Civil Eng., Lehigh Univ., Bethlehem Pa.

CONVENTION PARTY

Wednesday, Feb. 20

6:00 p.m. Victory Room, Heidelberg Hotel

This is the main social event of the Convention. There will be a social hour followed by a buffet dinner. Dr. Walter Johnston, of Vicksburg, will give his famed humorous talk on "The South Ain't Southern Any More." Dancing will start at 9:00 p.m. with music served Southern style by Jerry Lane and his orchestra.

Dress will be informal. All members, wives, and guests are invited to attend.

Price, $4.50 per person. No seating reservations will be taken. Tickets may be obtained at the Convention registration desk until 10:00 a.m., Wednesday, Feb. 20.

THURSDAY MORNING

FEB. 21

Construction Division

9:45 a.m. Rose Room, Heidelberg Hotel

Presiding: Walter L. Couse, M. ASCE, Pres., Walter L. Couse & Co., Detroit, Mich.

9:45 Pontchartrain Viaduct

Ross WHITE, M. ASCE, Vice President, Brown & Root, Inc., Houston, Tex.

10:30 Extruded Concrete Bridge Piers

C. M. DAVIS, M. ASCE, Consulting Engineer, Fort Worth, Tex.

Highway Division

9:30 a.m. Roof, Heidelberg Hotel

Symposium on Highway Planning and Finance

Presiding: Harmer E. Davis, Chairman, Highway Div., and Head, Dept. of Civil Eng., Univ. of California, Berkeley

9:45 Discussion of Highway Planning in Missouri and Mississippi

SAMUEL M. RUDDER, M. ASCE, Engr. of Highway Planning, Missouri State Highway Dept., Jefferson City, Mo.

10:15 I. W. BROWN, State Manager, Traffic Planning, Miss. State Highway Dept., Jackson, Miss.

10:45 Highway Planning—Past, Present, and Future

E. H. HOLMES, Deputy Commissioner; and JOHN T. LYNCH, A.M. ASCE, Chief, Planning Surveys Sect.; both, U. S. Bur. of Public Roads, Washington, D. C.

Irrigation and Drainage Division

9:30 a.m. Coronet Room, Edwards Hotel

Gravity Irrigation in Humid Areas

Presiding: Finley B. Laverty, Contact Member of Board of Direction for Irrigation and Drainage Div., and Chief Hydraulic Engr., Los Angeles County Flood Control Dist.

9:30 Gravity Irrigation Practice in the Southern States

JOHN R. CARREKER, Agriculture Research Service, USDA, Univ. of Georgia, Athens, Ga.

10:00 Water Supply in Relation to Irrigation in Humid Areas

M. C. BOYER, M. ASCE, Hydraulic Engr., Indiana Flood and Water Resources Commission, Indianapolis, Ind.

CLINTON LABORATORY FIELD TRIP

9:00 a.m. Thursday, Feb. 21

Trip: Visit to Corps of Engineers' main concrete laboratory and vast hydraulic model of the Mississippi River Basin at the Waterways Experiment Station Suboffice near Clinton, Miss., 9 miles from Jackson.

Transportation: By bus.

Departure: 9:00 a.m. from Heidelberg Hotel.

Return: 12:00 noon to Heidelberg Hotel.

Cost: Bus fare, round trip, $1.00.

Registration: At Convention registration desk not later than 2:00 p.m., Wednesday, Feb. 20.

10:30 Drainage, Irrigation and Engineering Practices of Soil Conservation Service Program

C. J. FRANCIS, Director, Eng. Div., Soil Conservation Service, USDA, Washington, D. C.

11:00 Adapting Surface Irrigation Methods and Land Leveling Procedures to Fit Humid Area Conditions

JOHN T. PHELAN, Irrigation Engr., Soil Conservation Service, USDA, Lincoln, Nebr.

Soil Mechanics and Foundations Division

9:30 a.m. Crown Room, Edwards Hotel

Presiding: C. I. Mansur, M. ASCE, Asst. Chief, Embankment and Foundation Branch, Soils Div., Waterways Experiment Sta., Corps of Engineers, Vicksburg, Miss.

9:30 Drilled Pile and Drilled-and-Belled Caisson Foundations

B. S. PERSONS, A.M. ASCE, Resident Partner, Dames and Moore, Atlanta, Ga.

Discussion

10:15 Relative Density, Grain Size, and Shear Strength of Cohesionless Soils

T. H. WU, J.M. ASCE, Asst. Prof. of Civil Eng., Michigan State Univ., East Lansing, Mich.

Discussion

11:00 A Modern Approach to an Old Underpinning Technique

W. F. SWIGER, M. ASCE, Consulting Engineer, Stone and Webster Eng. Corp., Boston, Mass.

Discussion

Structural Division

9:30 a.m. Club Room, Edwards Hotel

Presiding: Armour T. Granger, Chairman, Program Committee, Structural Div., and Prof. and Head, Civil Eng. Dept., Univ. of Tennessee, Knoxville.

9:30 Aluminum Applications for Highway Bridges

J. M. PICKETT, J.M. ASCE, Aluminum Co. of America, New Kensington, Pa.

10:00 A Method of Selecting the Cross Section of a Composite Concrete and Steel T-Beam

R. S. FOUNTAIN, Bridge Dept., Georgia State Highway Dept., Atlanta, Ga.

I. M. VIEST, J.M. ASCE, Assoc. Prof., Dept. of Theoretical and Applied Mechanics, Univ. of Illinois, Urbana.

10:30 Testing Full-Size Post-Tensioned Slab and Beam Without Grouting
ZACHARY SHERMAN, A.M. ASCE, Assoc. Prof., Civil Eng., Univ. of Mississippi.

11:00 Behavior and Shortcomings of Prestressed Concrete Practice
W. E. DEAN, A.M. ASCE, Asst. State Highway Engr., State Road Dept. of Florida, Tallahassee.

FACULTY ADVISERS' CONFERENCE

9:00 a.m. **All day**

Bamboo Room, Edwards Hotel

Sponsored by ASCE Committee on Student Chapters

Presiding: Ray K. Chalfant, Jr., Member, Committee on Student Chapters, Structural Engr., Prestressed Concrete of Georgia, Inc., Atlanta.

Faculty Advisers of 17 ASCE Student Chapters in the South and Southeast will convene upon invitation to discuss Chapter activities. This all-day conference, while primarily for Faculty Advisers, is open to any and all who may be interested.

VICKSBURG LABORATORY FIELD TRIP

1:00 p.m. **Thursday, Feb. 21**

Trip: Visit to the Waterways Experiment Station at Vicksburg, Miss., largest hydraulic laboratory in the world, and the Corps of Engineers' main laboratory center for soil mechanics, flexible (asphalt) pavement, vehicle mobility, and soils stabilization.

Transportation: By bus.

Departure: 1:00 p.m. from Heidelberg Hotel.

Return: 6:00 p.m. to Heidelberg Hotel.

Cost: Bus fare, round trip, $2.00.

Registration: At Convention registration desk not later than 2:00 p.m., Wednesday, Feb. 20

INFORMATION AND REGISTRATION

Information and registration facilities will be maintained in the corridor off the main lobby in the Heidelberg Hotel from Sunday, Feb. 17, through Friday, Feb. 22. Mail and messages will be held for members at the Information Desk.

LADIES HOSPITALITY ROOM

The Victory Foyer located on the mezzanine floor of the Heidelberg Hotel will be the place to meet other ladies attending the Convention. The Hospitality Room will be open Monday through Friday from 9:00 a.m. to 5:00 p.m. Hostesses will be in attendance at all times. Coffee will be served from 9:00 a.m. to 11:00 a.m. each day.

LADIES PROGRAM

Sunday, Feb. 17

Registration in South Lobby of Heidelberg Hotel, 3:00 to 7:00 p.m.

Monday, Feb. 18

Luncheon in Crown Room of Edwards Hotel, 12:00 noon, $2.50.

Icebreaker Party in Victory Room of Heidelberg Hotel, 5:00 to 6:30 p.m., $2.00.

Jackson Symphony Orchestra, Provine High School. Tickets at Registration Desk.

Tuesday, Feb. 19

Mayor's tour of Jackson. Buses leave from Heidelberg Hotel at 9:30 a.m., return 11:30 a.m. No charge.

Governor's Luncheon, Victory Room, Heidelberg Hotel, 12:15 p.m.—$2.50.

Movie "Magnolia Mansions and Moonlight" in Hospitality Room, following luncheon.

Tea at Governor's Mansion, 3:00 to 4:30 p.m. No charge. Mansion is located in heart of downtown Jackson, within easy walking distance of all hotels.

Music and one-act plays. Belhaven, Millsaps College program in Central High School Auditorium, 8:00 to 10:00 p.m., $1.00.

Wednesday, Feb. 20

Shopping during the morning, with special bargains offered to Convention guests.

Vicksburg Day. Busses will pick up ladies at 9:00 a.m. at Heidelberg Hotel for a trip to historic Vicksburg, Miss. Tour with trained guides will include Waterways Experiment Station, National Military Park, and other points of interest in and around Vicksburg. Luncheon will be served by the famous Old Southern Tea Room. Return to Jackson by 4:30 p.m. Cost $5.00 per person, including transportation, luncheon, and guided tours. Tickets may be obtained at the Registration Desk until 2:00 p.m., Tuesday, Feb. 19.

Social Hour in Victory Foyer, Heidelberg Hotel, 6:00 p.m. No charge.

Buffet Dinner and Dance in Victory Room, Heidelberg Hotel, 7:00 p.m.

Dr. Walter Johnston in dialect, "The South Ain't Southern Anymore." Jerry Lane's orchestra. Cost, $4.50.

Thursday, Feb. 21

Ladies are encouraged to accompany their husbands on a field trip by bus to the Waterways Experiment Station at Vicksburg. Buses will leave the Hotel Heidelberg at 1:00 p.m. Following a short tour of the Station, ladies have been invited to the Vicksburg Garden Club's Camellia Show, and to a tea at the home of Gen. and Mrs. John R. Hardin. Cost $2.00 round trip. Tickets may be obtained at the registration desk until 2:00 p.m., Wednesday, Feb. 20. Return to Jackson by 6:00 p.m.

JACKSON CONVENTION COMMITTEES

General Committee

Sydney W. Chandler, *Chairman*
Boyce H. Biggers, *Vice Chairman*
Joseph B. Tiffany, *Vice Chairman*

Steering Committee

Norman R. Moore, *Chairman;* Ben T. Collier, Francis E. Hall, Maj. Gen. John R. Hardin, Abby W. Hardy, Garner W. Miller, Arthur C. Miller, Col. Andrew P. Rollins, Jr., Raymond W. Sauer

Technical Program Committee

Willard J. Turnbull, *Chairman*

Entertainment Committee

Eugene M. Johnson, *Chairman*

Hotel Committee

Boyce H. Biggers, *Chairman*

Finance Committee

Guy L. Arbuthnot, *Chairman*

Registration Committee

Henry C. McGee, *Chairman*

Reception Committee

Arthur C. Miller, *Chairman*

Publicity Committee

Charles S. Hill, *Chairman*

Student Activities Committee

Charles R. Foster, *Chairman*

Transportation Committee

James E. Foster, *Chairman*

Ladies Committee

Mrs. Sydney W. Chandler, *Chairman*

. . . . . Am-Soc Briefs

▶ ▶ A major step has been taken with the issuance of the first certificate by the American Sanitary Engineering Intersociety Board to Earnest Boyce. Professor Boyce has long served the profession as chairman of the Joint Commmittee. He thus becomes the first engineer in any field to receive a specialist certificate (see page 83).

▶ ▶ Operating on the theory that the best way to find out what a man thinks is to ask him, the San Francisco Section Junior Members have queried about 200 of their number on employment conditions. Professional status and pay after several years experience ranked high among the dissatisfactions. Eighteen out of nineteen would not voluntarily join a trade union (see page 79). . . . The Maine Section has just come off the press with its brand new publication, The Yankee Engineer. . . . Also just off the press is the revised Local Section Handbook. Expanded coverage on public relations has been added to aid Section officers in their planning.

▶ ▶ Planners of the EJC General Assembly next January are thinking big. Two-day program is to include sessions on the engineer in defense, the engineer in the "cold war" and what he should be paid to do all this (see page 81). . . . Plans are also well along for the Nuclear Congress being held in March in Philadelphia. "Atomic Energy in Industry" and "Hot Laboratories and Equipment" will both be the subjects of two-day sessions. In all 40 sessions are planned by EJC. . . . A Survey of Engineering Faculties by EJC found many schools actively encouraging outside employment during summer months as well as fostering research and consulting assignments. The survey showed that base salaries are supplemented up to 25 percent in this way.

▶ ▶ Ever ask yourself, "Where did I see that article about . . .? The Index to Proceedings, cross indexed under four headings, and the Index to "Civil Engineering" out this month are a big help in searching out those obscure facts and figures you misplaced during the year. Copies may be obtained by writing to Headquarters.

▶ ▶ Congratulations are in order to the Society's pipeliners on achieving full Division status. Typically, they have lost no time in getting into operation, with technical sessions planned for the Jackson, Chicago, and Portland (Ore.) Conventions.

▶ ▶ Preparing a paper for publication by ASCE? Then the new "Technical Publications Handbook" is for you. Superseding the old Proceedings Paper No. 290, the new pamphlet was prepared jointly by the Divisions and the headquarters staff to answer the questions of authors, reviewers, and editors. Copies are available on request to Society headquarters.

SOCIETY NEWS

Do Local Sections Interest Junior Members?

COMMITTEE ON JUNIOR MEMBERS

Hamilton Gray, *Chairman*
Frank W. Edwards
Finley B. Laverty
James M. Morgan, Jr.
E. W. Carlton, *Contact Member*

Convinced that Junior Member activity in the Local Sections is a prime source of ASCE strength and that such activity will influence the destiny of the Society, the Committee on Junior Members has conducted a survey—by means of a questionnaire mailed in June 1956—to ascertain the extent of participation in Local Section affairs. Replies were received from approximately two-thirds of all Local Sections and are tabulated in Table I.

It has been assumed that payment of Local Section dues is a measure of interest and possibly also of activity in Local Section affairs. While this assumption may not be wholly reliable, it appears to have merit in that data can be secured readily. Conversely, it seems reasonable to suppose that failure to pay Local Section dues indicates lack of interest and activity. Interest may be lacking despite the payment of dues, but this is likely to be only a transitory condition.

The data obtained from the survey have been divided into categories based on Section size. Fig. 1, which is derived from these data, shows that the preponderance of Local Sections enjoy contributions from between 40 and 50 percent of their allocated Junior Members, while a smaller number of Sections receive considerably more, or less, support. Although many factors, such as geographical distribution, influence Local Section activity, it appears that neither size nor geographical situation is a determining factor if subscription to ASCE Local Sections is a valid measure.

Please mail comments to the new Chairman of the Committee on Junior Members: Trent R. Dames, 816 West 5th Street, Los Angeles, Calif., before February 5, 1957.

The Committee on Junior Members is particularly concerned that there were 2,399 losses from the Junior Member group during the year ending September 30, 1956. Of those "lost," 535 transferred to higher membership, 1,042 were dropped for non-payment of Society dues, and 637 were dropped upon reaching the age limit (age 32 in most cases) because they either did not take the trouble to apply for upgrading or were ineligible for Associate Membership. There were 175 resignations from the Junior Member group and ten deaths. The losses were offset by a gain of 2,202 who entered the Junior classification, principally recent college graduates. The net loss was 197, as shown on page 28 of the 1956 Annual Report. These figures are disturbing, indeed, in a technical age when there appear to be serious engineering manpower shortages.

The latest Society records indicate that 55.4 percent of its total membership are in either the Member or Associate Member grade, while 44.6 percent are Junior Members.

In Table I, it will be noted that answers were received from 47 Local Sections representing an allocated total membership of 26,207. The committee determined that 53.4 percent of this number pay Local Section annual dues thereby indicating interest and perhaps participation in Section activities. Upon further analysis it was discovered that this average percentage is misleading; the sampling indicated that of all those paying Local Section dues, only 35.2 percent are Junior Members while 64.8 percent are in the Member and Associate Member groups.

Local Section activity is presumed to be a function of Local Section policy, officer enterprise, and committee energy. The Committee on Junior Members will attempt next to ascertain tangible reasons for the high degree of activity in some Sections, and make known to less active Sections the policies and procedures which have proved successful elsewhere. Particular emphasis will be given to those policies which appear to affect Junior Member participation.

It is believed that Junior Members expect and are entitled to more than "technical" information in the form of Society publications. Local Section ac-

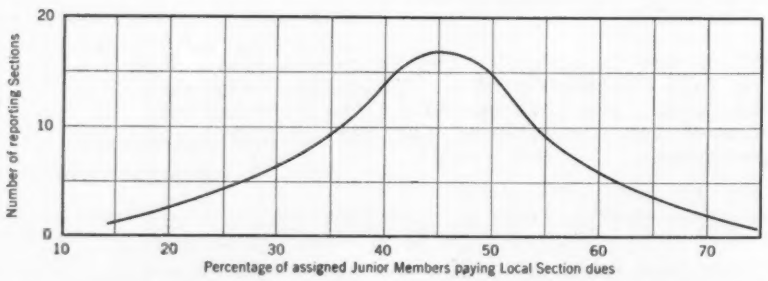


Fig. 1. derived from data obtained in survey shows that the preponderance of Local Sections enjoy contributions from between 40 and 50 percent of their allocated Junior Members.

tivity leads to more effective consideration of problems associated with "Conditions of Practice" and aids in establishing communication with Headquarters when difficult problems arise in this domain.

If support of the ASCE and its effectiveness as an organization are to be increased, the Local Sections will play an essential part. It is anticipated that Local Section officers and members will welcome this analysis and will aid the committee by supplying ideas which will increase the effectiveness of local organizations. These comments will be summarized in a subsequent article describing ideas deemed helpful to all Sections in improving their effectiveness.

ECPD Reports at Its Annual Meeting

The training program developed by the Training Committee of the Engineers Council for Professional Development was one of the primary topics at the recent two-day annual meeting of ECPD, which was held in Detroit. Meeting in the beautiful headquarters building of the Engineering Society of Detroit, host for the occasion, the group was welcomed by Prof. Earnest Boyce, M. ASCE, president of the ESD. Mayor Albert E. Lobo also extended the hospitality of the city.

TABLE I. Junior Member Participation in Local Section Affairs, June 1956

Size	Section	Membership: Allocated	Membership: Dues-Paying	% Allocated Paying Section Dues: M.* & A.M.*	% Allocated Paying Section Dues: J. M.*	Committee Membership: J.M.÷Total	Sections Officers: J.M.÷Total
Over 2,000	Los Angeles	2506	1400	68.3	40.2	0.33	0
	Metropolitan	3800	1868	68.5	30.0	0.29	0.33
	San Francisco	2403	1217	54.0	44.0	0.20	0.14
	Texas	2084	1169	65.0	42.0	4.07	0.16
1,000 to 2,000	Illinois	1387	808	74.5	41.2	0.27	0.27
	National Capital	1287	827	....	....	0.11	0.23
	Philadelphia	1300	650	....	....	....	....
300 to 1,000	Alabama	421	251	65.0	53.0	0.06	1.00
	Colorado	578	253	54.9	28.9	0.09	0.40
	Connecticut	489	215	51.0	34.0	0.29	0
	Florida	524	208	44.0	35.0	0.26	0
	Georgia	555	304	57.0	49.0	0.32	0.25
	Indiana	523	363	80.0	62.0	....	0.25
	Iowa	304	225	85.6	65.1	0.32	0.17
	Kansas	385	224	74.0	47.0	0.50	0.33
	Kansas City	590	413	81.0	57.0	0.51	0.14
	Maryland	738	446	72.3	45.0	0.05	0
	Mid-South	526	249	61.0	30.0	0.48	0
	Northwestern	610	190	33.2	31.4	0.33	0.25
	Oklahoma	362	170	64.1	32.6	0.15	0.12
	Oregon	528	352	....	....	0.45	0.44
	Pittsburgh	776	455	66.2	52.2	0.33	0.40
	Sacramento	718	586	81.2	82.4	0.23	0.17
	Seattle	621	480	88.0	70.0	0.53	0.40
	St. Louis	508	314	73.0	51.0	0.33	0.17
	Tennessee Valley	443	268	65.0	50.0	0.19	0
	Virginia	606	248	43.0	38.0	0.40	0
Less than 300	Arizona	243	126	51.9	42.7	0.22	0.28
	Central Ohio	283	128	72.0	20.0	0.14	0.25
	Cincinnati	211	128	72.0	47.0	0.20	0
	Columbia	97	68	85.0	41.0	0.13	....
	Dayton	164	73	....	....	0.39	0.20
	Delaware	220	96	51.0	30.0	0.11	0
	Hawaii	256	174	88.0	51.0	0.72	0
	Intermountain	244	81	47.0	19.5	0.67	0
	Kentucky	294	157	68.5	41.5	0.25	0.14
	Lehigh Valley	164	91	65.0	44.0	0.20	0.25
	Maine	171	112	78.0	51.0	0.16	0.17
	Mexico	70	48	70.0	64.0	0.12	0
	Mid-Missouri	150	85	70.0	46.0	....	0.17
	San Diego	250	162	78.0	35.0	0.60	0.30
	S. Carolina	256	135	53.6	51.7	0.12	0
	Southern Idaho	116	50	64.0	22.0	0.21	0.25
	Spokane	162	101	77.5	47.5	0.32	0
	Syracuse	195	51	24.0	28.0	0.56	0.40
	Tacoma	201	121	74.0	45.0	0.23	0.16
	Toledo	143	71	51.0	42.0	0.38	0.50
	Tri-City	85	42	60.5	40.4	0.34	0.33
	W. Virginia	179	128	78.0	57.0	0.12	0
	Wyoming	106	63	70.0	54.0	0.67	0.40

* M.=Member; A.M.=Associate Member; J.M.=Junior Member

Begun several years ago, the training program has been undertaken in several industrial communities of the United States and Canada. It is called "The First Five Years of Professional Development," and its aim is to provide a sense of purpose to young engineers in their first years out of college and to help them in developing that sense. Cincinnati industries and educational institutions were the first to take positive steps. Next came the Detroit area, with the ESD taking the lead in stimulating employers of young engineers to participate in the Detroit Industry Engineering Training Program. Now preliminary meetings are being held in the Minneapolis-St. Paul area to implement such a plan there. A number of industrial and educational leaders contributed to panel discussions concerning the effectiveness of the Detroit program.

ECPD's annual report for 1956 was presented at one session. Preprinted preliminary copies had been distributed. In presenting the report, President Thorndike Saville emphasized the need for a larger group of engineers who are engaged "in the design, construction, and administration of substantial engineering enterprises" to serve on ECPD committees and to represent the constituent societies. He believes that the governing boards of the various societies should keep themselves better informed about ECPD. If they did, he said, there would be less criticism by the members about the "alleged lack of concern of the societies with matters other than technical . . ."

Merger of ECPD and EJC proposed

Concerning a proposed merger of ECPD with Engineers Joint Council, President Saville had this to say: "The two organizations have never worked together more cordially than in recent years. . . . The effectiveness of both would be materially advanced if there were some form of official affiliation." He believes that the time seems propitious to move forward toward greater solidarity of the profession as a joint approach toward meeting "collective responsibilities for the welfare of mankind."

Survey of the profession

As one of the areas of recent collaboration, Dean Saville named the proposed Survey of the Engineering Profession. The report of the EJC-ECPD Task Committee recommended that the two bodies and their constituent societies institute a comprehensive examination

of the whole profession—estimated to take as long as two years and to cost upward of $1,000,000. ECPD has approved the report of the joint committee. Already financial support has been pledged by the ASCE, AIME, ASME, AIEE, AIChE, and ASEE to get the survey started. [The ASCE Board of Direction has also provided funds for a pilot survey of the civil engineering segment of the profession.]

Student guidance

ECPD's Guidance Committee reported that its well-developed organization in the United States, Canada, and Hawaii is continuing to bring student guidance to large numbers of secondary school students. Copies of the fourth revision of the folder, "After High School—What," has been mailed to principals and superintendents of secondary public, private, and parochial schools with an offer to supply counseling. Counselors are receiving the same folder, plus a reprint of "Accredited Curricula Leading to First Degree in Engineering" and a manual for those active in student guidance work. For further help in guidance work ECPD has printed 100,000 copies of the third edition of "Engineering, a Creative Profession."

A measure of the extent of the work of the Guidance Committee and its regional, state and local chairmen—all of it voluntary—is the conservative estimate of 1,650 schools visited and 118,260 students contacted during the year. To these impressive figures may be added participation in local Career Day programs, inspection trips to industry, PTA meetings, meetings with school counselors, and radio and television showings. Local sections of national societies are urged to cooperate with local guidance committees, if there is one and, if not, to organize one with the help of members of other local sections.

Accrediting curricula

One of the important activities of ECPD's Education and Accreditation Committee is the inspection of curricula at engineering schools. During the past year 208 curricula at 78 engineering schools were examined. Among those examined by the committee and accredited by ECPD was the civil engineering curricula, not previously listed, at Southwestern Louisiana Institute at Lafayette, La. Dean Harold L. Hazen, who has been a member of the committee for the past six critical years and is now retiring chairman, received the "high admiration and gratitude of ECPD for the enlightened statesmanship" brought to the committee, "constituting a service of high order to the engineering profession."

Student development

A major activity of the Student Development Committee during the past year was to develop guidance for students still in engineering college. "Dropouts" in engineering have been due to discouragingly low grades, interest in another subject, lack of money, and entering the armed services. Failures come from lack of motivation, lack of aptitude, and faulty counseling in high school.

The committee believes that strong student chapters aid in promoting professional activities in college. Student chapter participation, the report states, "provides a simple, professionally attractive, and economical transition into vitally important professional development of the young engineering graduate." Students who drift through college do not become the technical leaders we need so badly. The committee hopes that its guidance methods will result in graduating more of the capable students.

Professional recognition

Recognition of a profession requires a definition of it. For engineering the following definition was submitted as the result of a year-long study of the preliminary statement published in 1955.

"Engineering is the profession in which a knowledge of the mathematical and physical sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the progressive well-being of mankind."

ECPD's Recognition Committee is making a restudy of the membership grades in the constituent societies, with the objective of suggesting some uniformity in grade requirements and nomenclature. It is also studying the suggestion that the profession provide itself with a new designation to replace "Professional Engineer."

To many members of the engineering profession, especially the younger men, having their employers make maximum use of their creative abilities takes precedence over salary. The training committee encourages and recommends self-analysis and continued study; active participation in an engineering society by writing and presenting papers; leadership on committees; prompt advancement to the highest grade of membership for which he is qualified; and establishment of his legal standing as a professional engineer by registration.

Ethics

Over a period of years, the Ethics Committee reported, more than 80 engineering societies have endorsed ECPD's Canons of Ethics; several of them have adopted the Canons as their own codes of practice and ethics.

"There seems to be a tendency among engineers," this Committee's report states, "to assume that technical competence is the sum total of professional responsibility. Of equal importance . . . is his integrity. He commands confidence . . . by knowing his business, . . . likewise by his reputation for honesty. The ordinary client is not competent to appraise the engineer's work, . . . he is completely dependent on him. Since he is completely dependent on him the client must be assured that the engineer is both technically competent and morally responsible.

"To be morally responsible means that he subscribes to and complies with an established set of ethical principles which is recognized by the profession. Such an established set of ethical principles are the Canons of Ethics for Engineers of ECPD."

The Committee believes that an understanding of and concern about ethics among engineers can be improved by holding open sessions at ECPD meetings; by influencing constituent societies to do so; by encouraging publication of articles and papers; and by publication of ECPD pamphlets on ethical procedures.

New officers

For the 1956-1957 presidency M. D. Hooven was elected to succeed Thorndike Saville; and E. O. Kirkendall, secretary of AIME, succeeds W. H. Wisely, Executive Secretary of ASCE, as secretary. Copies of the 1956 Annual Report of ECPD are available from S. L. Tyler, Executive Secretary of ECPD, 25-33 West 39th St., New York 18, N. Y.

Handbook of Local Section Operations

Local Section officers and committeemen have been supplied with the most recent (November 1956) revision of the "Handbook of Local Section Operations." The revision has been approved by the Board of Direction for the guidance of members elected to make the operations of their Local Sections effective. Especially valuable is a new section on how to establish good relations with the public.

The revision is the work of the Society's Committee on Local Sections (of which Elmer J. Maggi is chairman), assisted by the headquarters staff. Although the new handbook is primarily intended for Section officers, other interested members may obtain copies on request to the Executive Secretary.

San Francisco Junior Members Report on Employment Conditions

One of the primary causes for unionization mentioned in the May 1956 report of the special committee of the Junior Member Forum of the San Francisco Section, entitled "Engineers and Unions," was dissatisfaction with professional status. In order to obtain a sampling of the causes of this dissatisfaction, at least among the young members of ASCE and other young civil engineers in the San Francisco Bay area, a questionnaire was distributed among them. Replies were received from 205. The questions related to: (1) types of employment respondent was engaged in; (2) evaluation of conditions of employment; (3) means of improving unsatisfactory aspects of employment; (4) union membership; (5) adequacy of control by registration; and (6) causes of "alleged" shortage of engineers.

Types of Employment. About half (47 percent) were found to be employed in consultants' offices; about one-quarter (26 percent) by public agencies; 14 percent by industry; 8 percent by contractors; and 5 percent in miscellaneous work.

Pay. Two out of three considered the major inadequacy of civil engineering employment to be related to salaries. Starting salaries were considered satisfactory, but become increasingly inadequate after a number of years of experience. Six out of seven felt that civil engineers with ten years' experience are not receiving pay commensurate with the work they are performing.

In the accompanying Fig. 1, from the report, are curves of the salaries actually received in the classifications shown, and a single dotted curve showing the salary believed by the respondents to be adequate. At ten years, on the average, the desired monthly salary is about $900, whereas the actual is about $700.

Improved Status. To improve the salary situation and to obtain better professional recognition ASCE—in some unstated revised status—was thought to offer the best means. Professional collective bargaining groups were a close second.

Union Membership. Trade unions were not looked on with favor. A majority of 18 to 1 would not join one voluntarily; and a ratio of 5 to 1 would seek other employment rather than be forced to join a trade union. More of these young civil engineers favored a revised ASCE than any other agency or method.

The registration law for civil engineers in California was believed adequate by a 60 percent majority of those responding, but many believed that the law should exercise control over the ethics of practice as well as the right to practice.

The alleged shortage of engineers was believed primarily to be the result of the misuse of the engineering talent available rather than an actual shortage of men.

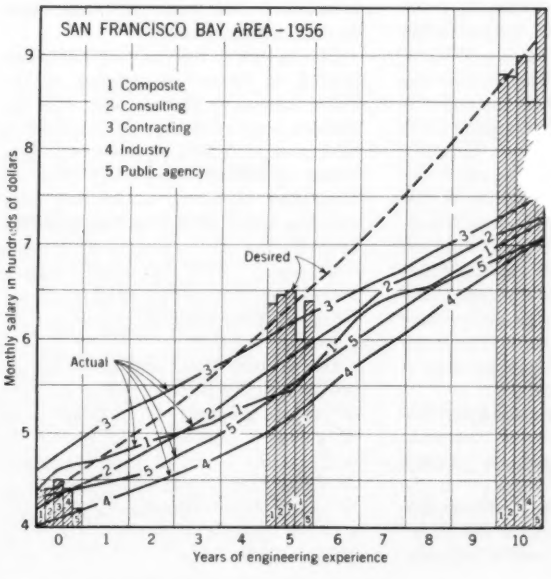


Fig. 1. Actual and desired salaries of civil engineers in San Francisco Bay area, 1956. From report of Special Committee of San Francisco Section's Junior Member Forum.

Carl L. Monismith, J.M. ASCE, Room 117 Engineering Building, University of California, Berkeley 4, Calif., Chairman, stated that the committee expects to make suggestions for a revision of ASCE status and for means of improving salaries of engineers with a number of years of experience, giving consideration to the relationship between salaries, fees, competitive bidding, and the registration system. He welcomes suggestions.

Joseph Barker, M. ASCE Becomes EJC President

Joseph Warren Barker, M. ASCE, chairman of the board and president of the Research Corporation, was elected president of Engineers Joint Council for 1957 at a recent meeting of the EJC board of directors. Dr. Barker, who will take office in January, has been serving as president of the American Society of Mechanical Engineers during the past year. He is a former dean of engineering at Columbia University, and was special assistant to the Secretary of the Navy from 1941 to 1945.

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Fischer S. Black, publisher and editor of *Electrical World*, was elected vice-president of EJC.

ASCE MEMBERSHIP AS OF DECEMBER 10, 1956

Members	9,277
Associate Members	12,241
Junior Members	18,080
Affiliates	73
Honorary Members	44
Total	39,715
Dec. 9, last year	38,866

Engineering Manpower Commission Report—1956

GAIL A. HATHAWAY, Past-President ASCE

(Past-President Hathaway, who is the Society's representative on the Engineering Manpower Commission of EJC, presented this report to the ASCE Board of Direction at its Pittsburgh meeting in October)

These are the basic program goals of the EMC:

1. To aid in maintaining the supply of trained engineers.
2. To promote the most effective utilization of engineers in maintaining the national health, safety and interest.
3. To aid in establishing the importance of the engineering profession through the national economy.

While these basic goals have remained the same during the EMC's five years of operation, the rapidly changing situation—often the result of achieving objectives—has led to changing emphasis in the detailed operations of the Commission.

Early in 1956, as a result of its studies of population trends and student growth, EMC asked the deans of engineering to estimate the capacity of their schools, principally in terms of teaching staffs to handle successfully an enlarging student population. The results of this study will be published shortly by the EMC and will provide a much-needed appraisal of the realities of the problems facing engineering education.

Acting jointly with the Scientific Manpower Commission, the EMC has authorized and scheduled a national meeting for early in 1957, which will be co-sponsored by the National Research Council and the National Science Foundation. The purpose of the meeting will be to give national expression to the unique problems facing technological higher education now and in the years ahead.

A joint subcommittee of the EMC and the SMC is currently about midway through the task of preparing a comprehensive statement on problems of education for the engineering and scientific professions. It is expected that this statement, having been adopted by Engineers Joint Council, will act as a guide to the EJC constituent bodies as well as to the hundreds of local engineering and scientific groups who have expressed interest and concern for problems in education.

During 1955 the 84th Congress made several important amendments to the military service laws involving the training and utilization of military-age engineers. EMC has worked closely with the appropriate government agencies in developing regulations implementing these laws. The Commission has actively engaged in the dissemination of information regarding these programs to employers, young engineers, and others interested in the utilization of our engineering manpower resources. The EMC-SMC Newsletter has been one of the most effective mediums in the country for providing this function. At the EJC General Assembly, one session arranged by EMC provided an opportunity for wide discussion of the subject with the responsible government officials. The problems of identification and classification in this area have been largely solved, and the remaining need is for improved utilization.

In March President Eisenhower appointed a National Committee for the Development of Scientists and Engineers, under the chairmanship of Howard L. Bevis, with a staff housed in the offices of the National Science Foundation in Washington. The engineering profession is represented on the committee by the president of Engineers Joint Council (Thomas H. Chilton in 1956). EMC has provided staff support to the president of EJC for his activity on the committee which also contains representatives from other outstanding national organizations. Thus far, this Presidents' Committee has appointed five task groups to make studies and prepare policy guidance reports for it. The secretary of EMC has served as a member of three of these task groups.

In April the Subcommittee on Research and Development of the Joint Congressional Committee on Atomic Energy held extensive hearings on the problems of engineering and scientific manpower. The chairman of the EMC, accompanied by the executive secretary, testified at these hearings on behalf of Engineers Joint Council.

In July the Secretary of Defense appointed a high-level committee, under the chairmanship of the president of the General Electric Co., to study the various problems of technical manpower in the Department of Defense and make recommendations to the Secretary for remedial action. EMC has taken every opportunity to bring pertinent information to bear in the various subgroups of this committee and has participated in numerous informal meetings whose purpose was the development of pertinent information to help the government provide a climate of engineering employment adequate to meet its great, important and, to a disturbing extent, unfilled requirements for engineering personnel.

EMC, in cooperation with the Special Surveys Subcommittee of the EJC Committee on Employment Conditions, made its annual demand survey for engineering curriculum graduates and published a report of this survey in July. The report is widely used in industry and government as a general guide to policy development in the field of engineering manpower.

Again, in cooperation with the Special Survey Subcommittee of EJC, EMC has launched a 1956 study of "Professional Income of Engineers."

The executive secretary of EMC was invited to become a member of the ODM Executive Reserve and, with the authorization of EMC, participated in Operation Alert 1956. In addition to providing a service opportunity, this arrangement facilitates liaison not only with the Office of Defense Mobilization but with the other government agencies —Defense, Labor, National Science Foundation, Commerce—which have mobilization responsibilities involving engineering personnel.

During 1956 EMC and SMC continued their active participation in the field of student guidance. Over 15,000 items of guidance material were placed directly in the hands of science teachers. Also EMC has permanent representation on a number of organizations concerned with the teaching of science to the youth of this country.

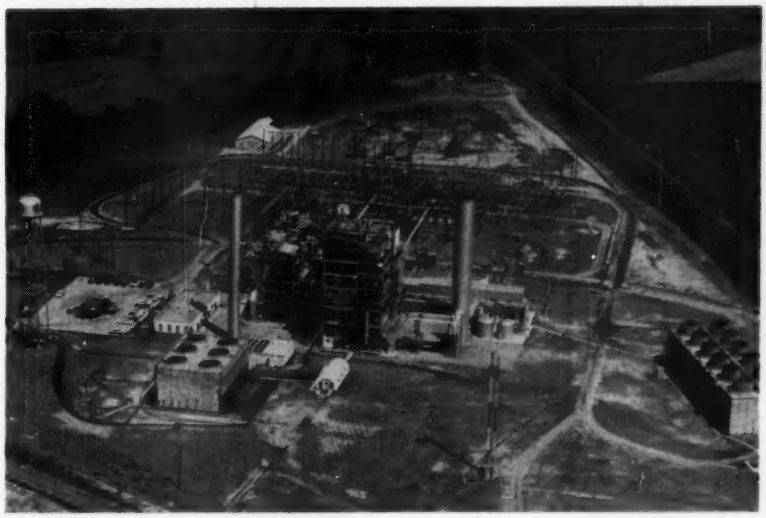
William H. McAlpine, Honorary Member, Dies

William H. McAlpine, Honorary Member of the Society and former special assistant to the Chief of Army Engineers, died in Washington, D. C., on November 1, at the age of 82. Mr. McAlpine, who lived in Washington, retired from the Corps of Engineers regular staff in October 1952. Because of his long and valuable experience, he had been retained on the staff of the Chief of Engineers beyond the usual statutory retirement age of 70.

An 1896 graduate of the Massachusetts Institute of Technology, Mr. McAlpine started working in 1902 for the Army Engineers in Cincinnati as a junior engineer. When he retired he had been for nine years a special assistant to the Chief of Engineers. Earlier he had been chief of the Engineering Division, Civil Works. Mr. McAlpine served as consultant on the design and engineering problems involved in constructing the third set of locks for the Panama Canal, the St. Marys Falls Canal, and the ore locks at Escanaba, Mich. He advised the TVA on engineering and design problems encountered in its projects, and was chief engineer on the extensive navigation developments on the Ohio and Upper Mississippi rivers.

Mr. McAlpine was chosen as one of fourteen charter members of the Gallery of Distinguished Civilian Employees of the Office of the Chief of Engineers, which was established on the occasion of the 180th birthday of the Corps of Engineers on June 16, 1955. He also received the War Department's Exceptional Civilian Service Award for his services in World War II. Mr. McAlpine was elected to honorary membership in ASCE in 1947.

Objective of Jackson Convention Field Trip



This is the Rex Brown Steam Electric Generating Station of the Mississippi Power and Light Company at Jackson, Miss., objective of one of the exciting inspection trips planned for the Jackson Convention. The plant, which is of the outdoors type because of the mild climate, has a capacity of 155,000 kw, and uses natural gas to supply steam for the turbines. Cost of the project was $14,300,000. The Waterways Experiment Station at Jackson and Vicksburg are among the other major tours on the Convention agenda. The full program, which will include sessions of all the Technical Divisions, is printed in this issue.

EJC General Assembly Set for New York City

The vital place of engineers—nationally in defense, internationally on the technological "cold front," and the salaries they should be paid in our expanding economy—are three paramount topics of the Engineers Joint Council General Assembly, to be held at the Statler in New York on January 17 and 18.

The two-day annual meeting will hear Maj. Gen. J. B. Madaris and Werner von Braun, of the U. S. Army Ballistic Missile Agency, as well as a senior representative of the U. S. Civil Service Commission and an authority on the highway program. There will be a Thursday afternoon panel analysis of the salary structure of engineers, with latest available data on the professional income of engineers and the principal methods of salary administration. The EJC Assembly Dinner on Thursday evening will have as principal speaker Henry T. Heald, M. ASCE, president of the Ford Foundation. At the concluding luncheon on Friday W. A. B. Illiff, vice-president of the International Bank for Reconstruction and Development, will discuss the engineer in the overseas picture.

Mining Engineer Wins Alfred Noble Prize

Mohamed Mortada, Junior Member AIME and senior engineer for the Magnolia Petroleum Co., of Dallas, Tex., is this year's winner of the Alfred Noble Prize, a joint award of the four Founder Societies and the Western Society of Engineers. The prize, consisting of a cash award of $400 and certificate, goes to Dr. Mortada for his paper, "Practical Method for Treating Oil-Well Interference in Water-Drive Reservoirs," published in the AIME *Journal of Petroleum Technology*.

Dr. Mortada received his B.S. degree from the University of Cairo and the degrees of M.S. and Ph.D. from the University of California. His prize-winning paper, which is also receiving an AIME award, is described by the Alfred Noble Joint Prize Committee as providing charts, "heretofore unavailable, which enable producers to anticipate, for extended periods of production, pressure changes at immediate and remote areas over a particular area. This knowledge enables better control of production costs, oil recovery, and valuation."

Both awards will be conferred at the annual meeting of the AIME, to be held in New Orleans, February 24-28.

Large Nuclear Congress Slated for Philadelphia

Peacetime uses of atomic energy will be the topic of the Nuclear Congress, scheduled for Philadelphia's Convention Hall, March 11-15, 1957, under the coordination of Engineers Joint Council. The session—the most extensive gathering devoted to the peacetime development of the atom since the United Nations Conferences at Geneva in 1955—will bring together leaders in science, engineering, industry, government, education, agriculture, and other fields. Dr. Walter G. Whitman, chairman of the Geneva Conference, will also head the 1957 congress.

Included in the Congress are four major elements, including the Second Nuclear Engineering and Science Congress, coordinated by EJC on behalf of twenty engineering and scientific societies. The latter will include a four-day program of 130 technical papers.

The National Industrial Conference Board will hold its Fifth Conference on Atomic Energy in Industry, featuring twelve round-table discussions, a dinner on Thursday, March 14, and a luncheon meeting on March 15.

The International Atomic Exposition, sponsored by the American Institute of Chemical Engineers in cooperation with four other engineering societies, will display industry's latest items in the atomic field.

The Fifth Hot Laboratories and Equipment Conference, sponsored by the Hot Laboratories Committee of the Oak Ridge National Laboratory, will take place on March 14 and 15 and deal with the operation and development of equipment for laboratories for atomic energy.

Meeting in Philadelphia to discuss the program for the forthcoming Nuclear Congress and International Atomic Exposition are Thomas H. Chilton (left), retiring president of EJC, and Joseph V. Friehl, director of the Atomic Exposition. Some fifty representatives of technical, business, educational, and government agencies took part in the preliminary planning conference.

According to Dr. Whitman, "The field of civilian atomic energy is growing fast, but is still very young. A basic problem is how to expedite the dissemination of information on new developments. Expositions like these help to make good use of the time of the few people we have with knowledge in this technical field."

Commenting generally on the Congress, Thomas H. Chilton, retiring president of EJC, said that "the true value of the Congress does not lie in its sheer size. Its significance lies in the fact that there will be an opportunity to gather in one place at one time, representatives of all of the many arts and sciences that are concerned with the rapidly growing field of atomic energy."

Program chairman for the 1957 Nuclear Congress is Bruce Prentice, of General Electric and member of the Executive Committee of ASME's Nuclear Engineering Division. Thomas A. Marshall, Jr., assistant secretary of ASME, is Congress manager, and Lewis R. Gaty, vice-president of the Philadelphia Electric Company, is chairman of the Philadelphia arrangements committee.

Attendance at the Nuclear Congress is expected to exceed the 3,000 at the Cleveland Congress in December 1955.

EJC Issues Survey of Engineering Faculties

With 85 percent of our engineering colleges understaffed by more than 10 percent, the nation's engineering deans are taking steps to alleviate manpower problems of engineering faculties by supplementing regular salaries with research opportunities, consulting work, and summer employment. This emergency treatment of the situation, according to a report released by Engineers Joint Council, is becoming a definite pattern in faculty employment practices, to help meet competition for qualified engineers.

According to the report, which is entitled *Engineering Faculties,* colleges not only permit, but encourage their faculties to take summer employment in industry and often develop specific programs with cooperating companies. When summer sessions are scheduled, many faculty members increase their income by as much as one-fourth of their base salary.

In commenting on the general manpower problems of engineering faculties, the deans emphasized that there is danger of oversimplifying the manpower problem by studying only numerical deficiencies. What many fear is the "insidious gradual deterioration" of the staff at the very time that engineering education is facing its greatest task.

Copies of the report are available from Engineers Joint Council, 29 West 39th Street, New York 18, N. Y.

New Printer for "Civil Engineering"

Beginning with this issue, CIVIL ENGINEERING will be published by the Rumford Press and mailed to members from Concord, N. H., where the Rumford plant is located. From the time CIVIL ENGINEERING was started (in October 1930) until now, it has been printed by the Mack Printing Company at Easton, Pa.

The 58-year-old Rumford Press has a long record of quality-magazine printing, and currently numbers among its sixty-odd publications *The Atlantic Monthly* and *Architectural Record.* Its impressive plant has facilities for both monotype and linotype. CIVIL ENGINEERING is now using the latter.

Study Made by J. Waldo Smith Fellow Completed

Peter L. Monkmeyer, last year's winner of the J. Waldo Smith Hydraulic Fellowship, has completed his study at Cornell University of "The Quadrant Edge Orifice." The conclusions reached in the report are as follows:

1. An equation has been developed for the prediction of variations in the discharge coefficient of any differential flow metering device, due to changes in the roughness of the upstream approach pipe:

$$dc = \frac{1.21\ C^3\beta^4\ df}{(1-\beta^4)}$$

2. Both from the equation and the experimental results, it is seen that increasing roughness in the approach pipe results in increasing the discharge coefficient of the quadrant edge orifice.

3. The equation, when applied to the discharge coefficient of the quadrant edge orifice, shows good agreement with experimental results for a change from aluminum to steel upstream pipe.

4. The equation, when applied to the discharge coefficient of the quadrant edge orifice, shows fair agreement with experimental results for a change from aluminum to old steel upstream pipe.

5. For commercial purposes, the equation will permit the correction of the quadrant edge orifice's coefficient of discharge, obtained in the laboratory calibration tests using aluminum upstream pipe, to account for the commercial steel pipe used in industry.

6. The magnitude of the correction of the discharge coefficient of the quadrant edge orifice increases with increasing β ratio. While correction is not needed for β ratios below *0.5*, above this value corrections of 0.1 percent or more become necessary. For β ratios above 0.6 additional data are needed.

7. Comparison with Koennecke's data reveals the importance of accuracy in manufacturing the quadrant edge, especially in the low ranges of the β ratio. Additional data are needed in this range.

8. The exchangeability of discharge coefficients of the quadrant edge orifice for corner and flange taps does not appear to be warranted without further research.

9. To complement the data compiled for the pipe Reynolds Number range above 5,000, further research is required in the range below 5,000. Thereby, the overall behavior of the quadrant edge orifice will become more clearly understood.

The report will be catalogued by the Engineering Societies Library where it will be available for reference to members of the Society.

New Award to Promote Research in Engineering

A major new award to encourage the potential and accomplishment of young research workers in engineering colleges is announced by the Engineering College Research Council of the American Society for Engineering Education, which is administering the award for the McGraw-Hill Book Co. Established in memory of the late Curtis W. McGraw, president of McGraw-Hill from February 1950 to September 1953, the award includes a cash prize of $1,000. It will be given annually to young men "who have made original contributions to engineering research and who have demonstrated high potential for future leadership."

Recipients will be selected by a special committee of the Research Council. Dean James R. Cudwoth, of the University of Alabama, is chairman of this year's selection committee. The first presentation of the award will be made at the 1957 annual meeting of the ASEE, to be held at Cornell University next June. Nominations should reach Dean Cudworth by February 1.

Freeman Fund Award Raised

Availability of a new Freeman Fund Fellowship is announced by the Committee on the Freeman Fund. An accumulation of money in the fund (up to $3,000, depending on the need claimed in the application) should make this year's stipend particularly attractive. ASCE and ASME are joint administrators of the fund. The Freeman Award Committee makes awards through these societies in alternate years, and in 1957 the award will be administered through ASCE.

The Freeman Fellowship is currently open to qualified members of ASCE or ASME who wish to pursue a worthy research program in hydraulics or related fields. Each applicant must submit a detailed prospectus of his research program, covering a period of at least nine months, and furnish evidence of his qualification to carry out the proposed program. Applications should also include a statement of the funds needed from the fellowship. Applications must be submitted by March 1, 1957, to the Freeman Award Committee, care of the Executive Secretary of ASCE, 33 West 39th Street, New York 18, N. Y. Announcement of the award will be made on April 15, 1957.

Suggested uses for the income from the fund include:

1. Grants toward expenses for experiments, observations, and compilations toward discovering valuable new engineering data.

2. Underwriting fully or in part some of the loss sustained in publishing meritorious books, papers, or translations.

3. A prize for the most useful paper relating to the science or art of hydraulics.

4. A traveling scholarship, open to members under 45 in any grade of membership, in recognition of achievement or promise, for the purpose of aiding candidates to visit engineering works in the United States or abroad.

First Sanitary Engineer Certified by New Board

Earnest Boyce, M. ASCE, professor of sanitary engineering at the University of Michigan, and former chairman of the American Sanitary Engineering Intersociety Board, has been awarded Certificate No. 1 by that Board. He thus becomes the first sanitary engineer to be certified by this Engineering Specialty Board. Professor Boyce served for many years as chairman of the Joint Committee for the Advancement of Sanitary Engineers, which organized and incorporated the Intersociety Board, and was the first chairman of the Board.

The first certificates were awarded at the recent annual meeting of the Intersociety Board when more than 200 applications were considered. Approximately 75 percent of the applications were approved for certification without examination, and 10 percent were rejected or held for further investigation. The balance were held for the first written examination to be given during 1957. Each successful applicant will be certified in one of the following five areas of "special qualification:" Water Supply and Waste Water Disposal, Public Health Engineering, Industrial Hygiene, Radiation Hygiene and Hazard Control, and Air Pollution Control.

Officers elected for the coming year, 1956-1957, were: Thomas R. Camp, of

Camp Dresser and McKee, Boston, Mass., chairman; Ray E. Lawrence, of Black & Veatch, Kansas City, Mo., vice-chairman; R. S. Rankin, of Dorr-Oliver Co., Stamford, Conn., treasurer; and Francis B. Elder, of the American Public Health Association, New York City, secretary.

Acceptance of sponsorship of the Board by the American Institute of Chemical Engineers was announced. This brings to six the number of sponsoring organizations.

The board was organized to elevate the standards and advance the cause of sanitary engineering. It is the first instance of a body established for issuance of certificates to mark attainment of a high order of recognition in a specialization by any of the branches of engineering. Until July 1, 1957, persons with 15 years of satisfactory experience may be certified without examination.

Further information and application blanks may be obtained from the Secretary, ASEIB, Room 1601, 33 West 39th Street, New York 18, N. Y.

Metropolitan Student Chapters Sponsor Career Conference

"What Should I Expect?" was the general theme of an all-day Conference of Metropolitan Student Chapters of the Society, held at Columbia University in the late fall. The attendance of about 150 represented the Chapters at the College of the City of New York, Columbia, Cooper Union, Manhattan College, Newark College of Engineering, New York University, Polytechnic Institute of Brooklyn, and Rutgers and Villanova Universities.

The first speaker of the day was E. K. Timby, partner in the New York consulting firm of Howard, Needles, Tammen and Bergendoff, who outlined his views on the "Opportunities for Young Civil Engineers." Mr. Timby presented civil engineering as a compromise between many variables, accomplished by 95 percent hard work and 5 percent glory. The choice of a career for the young engineer, Mr. Timby said, may be resolved by careful analysis of and due consideration to such variables as salary, personal satisfaction, and creative service. The young engineer should broaden his opportunities by gaining both field and office experience. He should also take advantage of the greatest opportunity life has to offer which is to enjoy what one is doing. Mr. Timby warned against "jumping to answers," as he called upon his audience to look at life as a great engineering project designed but once and deserving of the most careful analysis to the end of serving both oneself and mankind.

During a luncheon held at the Men's Faculty Club, the students studied literature distributed by seventy-five business concerns in the various branches of civil engineering and the numerous related fields.

The afternoon session began with a talk by Executive Secretary W. H. Wisely on the subject, "Ethics and Engineers." Mr. Wisely discussed various cases involving ethics which are typical in the engineer's experience, outlining in each case the behavior of a truly professional engineer as based on the ASCE Code of Ethics. The accent was on the experience of the young engineer and his need for founding his career upon ethical principles. Mr. Wisely stressed loyalty and honesty as the means of gaining the faith of both employer and client, which is a prerequisite to the gains and satisfaction of a professional career.

In the final presentation of the day Prof. T. Baumeister, of Columbia's Department of Mechanical Engineering, presented both a forecast and a challenge. In his talk entitled, "What a Power Engineer Sees Ahead for Civil Engineering in the Next Ten Years," Professor Baumeister outlined such advances in power engineering as increased production through the expansion of fossil fuel and the introduction of nuclear fuel-burning stations, the utilization of waste products from these stations, and the development of the heat pump. With these developments likely, Professor Baumeister sees civil engineering knowledge and ingenuity heavily taxed to make possible the power advances of the next ten years.

The conference, which proved enlightening and informative in the extreme, was closed by Ronald Williams, the conference vice-president.

On hand for the recent Metropolitan Conference of Student Chapters, to which the Columbia University Chapter was host, are (left to right in left-hand photo) Ronald Williams, vice-chairman; Larry Smith, chairman; and Lee Purcell, secretary-treasurer. Right-hand view shows Henry Boracci, president of host Chapter; Daniel Boyer, treasurer; and Robert Winters, Conference recorder.

Personnel of the Society's Professional Committees

At the Annual Convention each year the Board of Direction confirms the appointment of new ASCE committee personnel—the thousand or so prime movers in Society operation. The December issue listed new appointments to the Committees of the Board and the Auxiliary Administrative Committees, which were confirmed at the Pittsburgh meeting of the Board.

Among other appointments confirmed at Pittsburgh were assignments to the Society's eight Professional Committees, each of which is represented on the Conditions of Practice Executive Committee by a contact member. The new personnel of each of these eight committees is listed here.

The **Committee on Junior Members** is headed by Trent R. Dames as chairman (1958) and Frank W. Edwards as vice-chairman (1959). The other members are Nomer Gray (1960), James M. Morgan, Jr. (1957), and Finley B. Laverty, Contact Member (1957). With the approval of the Board, this committee puts into effect methods and procedures designed to benefit Junior Members.

The **Committee on Local Sections** is charged with the interests of Society members "resident in a given community and organized or capable of being organized into a Local Section." Its personnel consists of Elmer J. Maggi, chairman (1958); John R. Campbell (1957); John C. Voorhees, vice-chairman (1959); Frank C. Mirgain (1960); and Frederick H. Paulson, Contact Member (1957).

The **Committee on Student Chapters** can make and put into effect recommendations affecting the welfare of students of civil engineering. It is manned by Emory E. Johnson, chairman (1959); Charles E. Clarridge, vice-chairman (1958); C. Russell Dole (1957); Lauress L. Wise (1960); Ray K. Chalfant (1961); and Clarence L. Eckel, Contact Member (1957).

In addition to promoting engineering education, the **Committee on Engineering Education** is expected to work toward establishing a closer relationship between engineering schools and the engineering profession. Making up this committee are Roland P. Davis, chairman (1958); M. J. Shelton, vice-chairman (1959); Edwin H. Gaylord (1959); Jack E. McKee (1960); Weston S. Evans, Sr. (1957); James A. Higgs (1957); Clarence H. Ax (1958); Elmer K. Timby (1960); and Carey H. Brown, Contact Member (1957).

The slate for the **Committee on Registration of Engineers** is David G. Baillie, Jr., chairman (1958); Daniel C. Walser, vice-chairman (1959); William M. Spann (1957); John C. Park (1960); and Don M. Corbett, Contact Member (1957). Primarily this committee has the responsibility of aiding official engineer registration boards in their efforts to administer and strengthen registration laws. It is expected to organize in such a way that it can give maximum assistance at both national and local level in establishing and administering sound registration laws.

The **Committee on Professional Practice** gives attention to problems confronting civil engineers in the practice of their profession, whether of a business, legal, or administrative nature, not specifically assigned to other Society committees. It is also concerned with adequate fees for professional engineering services, contracts between engineers and clients, and investigation of special questions as they arise. The committee personnel includes Herbert C. Gee, chairman (1958); Lloyd D. Knapp, vice-chairman (1959); Karl R. Kennison (1957); William W. Moore (1960); and George S. Richardson, Contact Member (1957). Four additional members are to be added.

Appointed to the **Committee on Salaries** are Don H. Mattern, chairman (1958); Warren W. Parks, vice-chairman (1959); Dewitt C. Greer (1957); Oscar S. Bray (1960); and G. P. Willoughby, Contact Member (1957). This committee collects, codifies, and prepares for distribution material of value to both employers of civil engineers and civil engineering employees in connection with the proper classification of engineering positions and suitable compensation.

The economic and social conditions of employment come within the purview of the **Committee on Employment Conditions.** This committee is expected to organize so as to be of practical assistance to the Board in the adjustment of disputes arising out of conditions of employment. It is manned by Jack Y. Long, chairman (1958); Charles W. Griffin, Jr., vice-chairman (1959); Herbert F. Darling (1957); R. Earl Salveter (1960); and L. A. Elsener, Contact Member (1957).

New appointments to the Technical, Task, and Joint Committees will be announced in later issues.

Coming Events

Joint Area Committee—This group (consisting of members of ASCE, the Engineering Institute of Canada, and the Institution of Civil Engineers in the Toronto area) meets monthly in Toronto. The next meeting—to be devoted to planning Ontario highways—will be held on February 7. Details from the Secretary, B. Hardcastle, c/o McColl Frontenac Oil Company, Ltd., 8 Spadina Road, Toronto.

Metropolitan—Meeting in the Engineering Societies Building, January 16, at 7:00 p.m.

National Capital—Luncheon meeting on January 22; annual dinner at the Army-Navy Country Club on February 12.

Oregon—Annual dinner meeting on January 25. Details will be announced in the January issue of the "Oregon Civil Engineer."

Sacramento—Weekly luncheon meeting at the Elks Temple every Tuesday at 12 noon.

South Carolina—Annual winter meeting at the Columbia Hotel, Columbia, S. C., January 11, with the South Carolina Society of Engineers. Registration at 10:00 a.m.; luncheon at 12:30 p.m.; and banquet at 6:30 p.m.

Scheduled ASCE Conventions

JACKSON CONVENTION
Jackson, Miss.
Hotel Heidelberg
February 18-22, 1957

BUFFALO CONVENTION
Buffalo, N. Y.
Hotel Statler
June 3-7, 1957

ANNUAL CONVENTION
New York, N. Y.
Hotel Statler
October 14-18

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the fifth of the month preceding date of publication

Recent **Akron Section** meetings have featured talks by State Senator Fred Danner, who commented on a visit to the Soviet Union, and Floyd W. Krehl, whose subject was the Lift-Slab method of construction.

The **Juneau Branch** of the **Alaska Section** met on October 30 and elected the following new officers: John D. Argetsinger, Juneau, president; Felix J. Toner, Juneau, vice-president; and Alfred B. Bruck, Douglas, secretary-treasurer.

For the **Arizona Section** the new slate is Leigh O. Gardner, Phoenix, president; Clarence H. Whalin and Robert M. Cushing, Phoenix and Tempe, vice-presidents; and Edward C. Fraedrich, Phoenix, secretary-treasurer. The new secretary does not take office until February 1. He will be aided by James H. Deatherage, of Phoenix, who was elected junior assistant to the secretary-treasurer.

Principal speaker at a recent meeting of the **Central Illinois Section** was J. W. Briscoe, assistant professor of civil engineering at the University of Illinois, who described a summer vacation tour of engineering works. The projects he has studied at first hand range from the $100,000,000 Mackinac Bridge to St. Lawrence Seaway installations.

The radio telescope and radio astronomy were explained in a stimulating program put on by the **Central Ohio Section** on October 25. Dr. H. C. Ko was featured speaker, and his subject was "The Radio Sky."

The **Cleveland Section** will conduct a TV program this spring—one of a series of career guidance hours on the docket of the Cleveland Technical Societies Council. Problems involved in constructing the first radar station in the Atlantic were graphically put across in a film and talk highlighting the November meeting. The resident manager on the job for the Raymond Concrete Pile Co. was the speaker.

Big events are scheduled for a small city under the sponsorship of a small Section says the **Columbia Section** in announcing it will be host to the 1957 Pacific Northwest Council Conference, plus a meeting of the ASCE Executive Committee and a Local Section Conference. Details will be forthcoming later. In the meantime, the Section suggests that members keep the dates (April 25-27) open for the big event. Walla Walla, Wash., is the city. Council officers are Leigh M. Huggins, Southern Idaho Section, chairman; Glenn H. Von Guten, Columbia Section, vice-chairman; and Clifford R. Salmen, Southern Idaho Section, secretary-treasurer.

Members of the **Connecticut Section** joined the other engineering societies of the state on November 2 in helping the School of Engineering at the University of Connecticut celebrate the university's seventy-fifth anniversary. Each of the engineering departments conducted concurrent programs followed by a general session devoted to engineering education. At the evening banquet there were talks by Albert H. Jorgenson, president of the university; Earl C. McEachern, student president of the Tau Beta Pi Chapter; and Charles H. Kaman, president of the Kaman Aircraft Corp., who gave an inspiring address on "New Horizons in Engineering."

The **Duluth Section** has unanimously elected new officers. The slate is Myron O. Thompson, president; Robert A. Fredstrom, first vice-president; Albert J. Oman, second vice-president; John T. Adams, secretary; and Leo H. Ebert, treasurer. At recent meetings members have heard Walter Spannaus, design engineer for the Oliver Iron Mining Division of U.S. Steel, speak on modern methods of iron ore beneficiation, and R. A. Palmer, of the Koppers Co., Chicago, on coated steel pipe. At a recent meeting of the **Iron Range Branch** John Trenti, Virginia (Minn.) attorney, discussed the legal terms used in contracts and specifications and ways of handling problems involving contractors and owners.

The present status of the Augusta master sewerage system was the topic at the November 28 meeting of the **Georgia Section's Central Savannah Valley Branch,** and Charles C. Biddle, head sanitary engineer for Patchen and Zimmerman Engineers, the speaker. New Branch officers are C. D. Williams, president; M. A. Ruth, vice-president; and C. J. W. Smith, Sr., secretary-treasurer. C. W. Haasis, of Aiken, S. C., has been appointed Branch associate editor for the Section's publication, "Civil Engineering in Georgia."

Looking ahead to spring, the **Hawaii Section** is making plans for its annual conference, which is set for May 15—a

ASCE officers at national and local level get together during annual meeting of Georgia Section early in December. Shown in front row are retiring Section President Byron A. Bledsoe; Section President Burton J. Bell; ASCE President Mason G. Lockwood; and Society Vice-President Francis S. Friel. Pictured in the second row are Section Vice-President G. S. Jenkins, Jr.; G. B. Dalrymple, secretary-treasurer of Section; ASCE Director Graham P. Willoughby; Executive Secretary William H. Wisely; Section Vice-President C. E. Kindsvater; and Section Director P. J. Masciocchi.

date that will be convenient for engineers visiting California next spring to attend the ASCE Irrigation Division Conference and the Third World Congress on Irrigation and Drainage, to be held in San Francisco, and the Pacific Southwest Conference of Sections, scheduled for San Jose. The Hawaii Conference will be held in Waikiki, Oahu, and the theme, fittingly, will be irrigation.

Proposed changes in the Utah Engineer Registration Law are being opposed by the **Intermountain Section,** which has appointed a committee to keep it informed of any legislative action tending to jeopardize the law. Ralph Spears, district engineer for the Portland Cement Association, gave an enlightening talk on the new Highway Act at the November meeting.

The **Iowa Section** had two technical meetings at Des Moines on November 15. At the afternoon session the program consisted of talks by Harris F. Seidel, superintendent of the Ames treatment plant, whose subject was "Programming for Maximum Well Pump Efficiency," and Paul E. Morgan, assistant professor of civil engineering at Iowa State College, speaking on "Waste Treatment for the Milk Industry." In the annual election of officers Fred F. Loy was chosen president; Ralph H. Wallace, vice-president; and Cornie L. Hulsbos, secretary-treasurer. Mr. Hulsbos succeeds Lowell O. Stewart, head of the civil engineering department at Iowa State College, who is retiring as secretary-treasurer after many years of devoted service to the Section. At a dinner meeting in the evening Life Membership Certificates were presented to W. Neil Adams, Joseph K. Hilton, Willis H. Vosburg, Warren G. White, and Raymond R. Zack. Featured speaker was L. M. Clauson, deputy chief engineer of the Iowa Highway Commission, who discussed the state's 1957 construction program.

Vicksburg Branch planners for Society's Jackson Convention, to which the Mid-South Section will be host early in February, are pictured here. In usual order they are: Dean R. Freitag, secretary-treasurer of Vicksburg Branch; Col. A. P. Rollins, Jr., member, Steering Committee; Eugene P. Forston, member, Technical Program Committee; Mrs. Norman R. Moore, member, Ladies Committee; Mrs. Joseph B. Tiffany, member, Ladies Committee; Ray W. Sauer, president of Mid-South Section; Mrs. A. P. Rollins, Jr., member, Ladies Committee; Norman R. Moore, chairman, Steering Committee; Capt. R. L. Hunt, Finance Committee; and Charles R. Foster, chairman, Student Activities Committee.

Kansas Section members in the Wichita area are being canvassed to find out prevailing sentiment about forming a Branch. Section Vice-President Elwood Leeson discussed the proposed Branch at a recent meeting in Wichita. Featured speaker was Cecil Carrier, weather reporter for a local station, who discussed the difficulties of weather forecasting and the effect of weather on the human body.

Featured speaker at a recent **Kentucky Section** dinner meeting was Dr. William Furnish, of the University of Louisville biology department, whose interesting illustrated talk covered his vacation experiences. There was a turnout of almost 100.

Congratulations are in order for the **Maine Section,** which has released the

Under sponsorship of the South Dakota School of Mines and Technology Student Chapter, junior and senior civil engineering students visit Oahe Dam and Reservoir, which the Omaha Division of the Corps of Engineers is building near Pierre, S. Dak. A unit in the Pick-Sloan Plan for developing the Missouri River Basin, the multiple-purpose dam is a rolled-earth type structure, 9,300 ft long and 242 ft high and the second largest earth dam in the world. Here the group—headed by John W. Siebert and Charles R. Brown, area engineer and assistant area engineer for the Oahe Project—pauses in its five-hour tour to study the intake structures for the huge project. E. D. Dake, Faculty Adviser for the Chapter and vice-president of the School, was in charge of the group.

Slurry Sealing ahead of resurfacing as . . .

Bitumuls and Asphalt Put New Life in Famous Ridge Route on U. S. Highway 99

On a 41 mile stretch of the Ridge Route, (U. S. Highway 99), between Los Angeles, California, and the Kern County line, heavy auto, bus and truck traffic had caused serious deterioration of various sections of old pavement. So the California Division of Highways called for bids by June 21, 1956, for one of the largest resurfacing contracts ever let.

The job called for a total of 21 miles of multi-lane asphaltic concrete resurfacing; 13 miles of sub-sealing, crack-sealing, and priming of old rigid-type pavement ahead of resurfacing; 8 miles of sealing and priming existing bituminous four-lane divided roadway; and extensive shoulder work. Total estimated cost was over one-half million dollars.

A 3" ASPHALTIC CONCRETE COURSE of 200-300 Penetration asphalt, ½" to ¾" maximum-size aggregate, was used to restore riding qualities to old, rigid-type, three-lane pavement now serving as one-half the roadway on 13 miles of U. S. Highway 99.

Contract awarded—Successful bidder on the job was Schroeder & Co., Sun Valley, California. Completion was scheduled for January, 1957, so work began immediately. At a central site on the job, aggregate production and plant-mixing equipment was set up. Carefully-calculated Bitumuls and asphalt requirements were reviewed with the Field Engineers of American Bitumuls & Asphalt Co., and a precise delivery time-table was drawn up to keep all phases on the job moving.

Asphalt & Bitumuls big items—The quantities of asphalt and Bitumuls required are impressive: for sub-sealing, 1700 tons of Grade 10-25 Air Refined Asphalt; for resurfacing, 3500 tons of 200-300 Penetration Paving Asphalt; for seal and prime work, 140,000 gal. of Bitumuls.

Resurfacing rigid-type pavement—Here's how the job progressed: on the old rigid-type pavement, slabs were drilled and sub-sealed with air-refined asphalt. Then the cracks and joints were filled with either Bitumuls Slurry Seal, or a joint-sealing compound, or a combination of both.

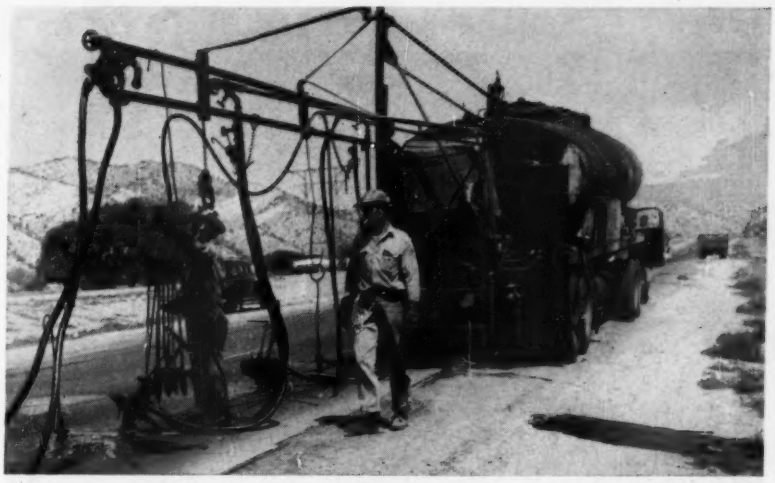
Asphaltic concrete (Paving Asphalt mixed with ½" to ¾" maximum-size aggregate) was then trucked from the

plant and spread in two lifts (a levelling course and a surface course) to provide a uniform 3″ thickness. Using two spreaders, each equipped with special shoulder extensions, this mix was placed to a full width of *37 ft. in a single pass.* In this way, despite long hauls (some up to 30 miles), as much as 1200 tons of mix were placed in a single day.

Resurfacing bituminous paving — The existing bituminous pavement required only a 1″ overlay of asphaltic concrete as opposed to the 3″ specified for the rigid-type section. Ahead of the placement of this 1″ thickness, Bitumuls Slurry Seal was used to seal and prime the old surface. (Bitumuls Slurry Seal is a mixture of Bitumuls Emulsified Asphalt, selected fine, sharp sand and/or fine stone screenings, and sufficient water to produce a free-flowing slurry. Batched into a transit-mix truck, these materials are mixed enroute; discharged onto the pavement; applied at full lane-width by a squeegee-mounted spreader-box).

This job, because of its unusual size and many complexities, provides an excellent example of the ability of American Bitumuls & Asphalt Co. to deliver a full line of asphaltic products to meet every need; and to furnish the on-job field-service that can often mean the difference between profit and loss. Whether your next project is a resurfacing operation or new construction, it will pay you to check with our office nearest you for *all* your asphalt requirements.

American Bitumuls & Asphalt Company
200 Bush Street
San Francisco 20, Calif.



HOLES WERE DRILLED in the rigid-type pavement at minimum intervals of ten feet. Air-refined asphalt (Grade 10-25) was then pumped in at an average of 27 gal. per hole to sub-seal the pavement.

CONTRACTOR SET UP modern aggregate production and mix-plant equipment at a central location on the job. Nature of project still required hauls of up to 30 miles.

THIS PHOTO, taken on one of the largest resurfacing jobs ever let, shows (left to right): Neil Boles, Field Engineer, American Bitumuls & Asphalt Co.; Johnny Hayden, Estimator and General Sales Manager, Schroeder & Co.; Bob Norman, Inspector, California Division of Highways; Everett Leucart, Job Superintendent, Schroeder & Co.; Don Frischer, Resident Engineer, California Division of Highways; Herb Belford, Assistant District Engineer, California Division of Highways; H. E. "Red" Schroeder, President, Schroeder & Co.

See you at the Road Show, Chicago, January 28—February 2; Booths 81-82, Materials and Supplies Section.

Members and guests of San Francisco Section (some 250 of them) were recently given preview showing of the Army Engineers' Bay Area Model at Sausalito. Group includes (in usual order) R. E. Blyberg, hydraulic engineer, San Francisco District of the Corps; W. D. Johnston, hydraulic engineer, San Francisco District; W. T. Hodgin, hydraulic engineer, San Francisco District; H. G. Dewey, Jr., chief, San Francisco Bay Section of San Francisco District; A. T. Guthertz, technical liaison, Engineering Section, San Francisco District; R. J. Johnson, chief, Planning and Reports Branch, San Francisco District; H. C. Medbery, vice-president, San Francisco Section; Section President R. D. Dewell; H. C. Wood, past-president of Section; and L. D. Doty, hydraulic engineer, San Francisco Section. H. J. Miles, hydraulic engineer, San Francisco District, conducted the tour. The model, which will cost about $300,000, is being built in 12-ft-square sections. In February all 155 sections will be in place, and the model will undergo correlation tests. Later it will be used to solve such problems as how to reduce dredging expense in the Napa-San Jose area.

first issue of its new quarterly bulletin, "The Yankee Engineer." About 35 percent of the 12-page bulletin carries advertising, which for the first issue more than covers printing and mailing costs. The issue is distinguished by three timely articles on the new highway program. Efforts will be made to expand the publication to include more Section news and possibly to provide a source of revenue for the Section. Aerial surveying as related to tax, municipal, and highway maps was discussed at a dinner meeting of the Section's **New Hampshire Branch** held in Concord on November 14. Maurice J. Perrier, secretary of Fairchild Survey, Inc., was featured speaker.

Planning for the Little Rock, Ark., area twenty-five years from now was described in the leading talk at a recent dinner meeting of the **Little Rock Branch** of the **Mid-South Section.** Gerald McLindon, acting director of Metroplan, which is in charge of planning for the area, described how the agency works and outlined the engineer's part in planning. Branch officers for 1957 are L. R. Barnett, Jr., president, W. D. Dickinson, Jr., vice-president; and A. C. Austin, secretary-treasurer. The influence the TVA has had on the nation at large was ably discussed at a meeting of the **Vicksburg Branch** by Brig. Gen. Herbert D. Vogel, chairman of the board of the TVA.

The **Montana Section's** new slate is as follows: Frank Stermitz, president; Jason E. Barton, vice-president (Billings Branch); Ashton R. Codd, vice-president (Helena Branch); Leland J. Walker, vice-president (North Central Branch); and John C. Beer, secretary-treasurer. Addressing a recent all-day meeting on various aspects of the highway program were Grant Meyer, principal highway engineer for the Bureau of Public Roads at Missoula; Henry Helland, assistant state highway engineer for the Montana State Highway Commission; and Fred Ratchye, chief engineer for Stanley Arkwright, Inc., highway contractors.

Outstanding students in the Washington area received the **National Capital Section's** annual awards at a Section meeting on November 13. Honored were Charles P. Carter, of Howard University, and Richard W. Rumke, of George Washington University. Both received $40 checks. Featured speaker was Gen. John S. Bragdon, special assistant to the President and coordinator for public works planning. In a talk entitled "Planning for Public Works," General Bragdon pointed out that there is real need for better planning at all government levels to avoid waste and insure coordination. He defined planning as a necessary activity for filling the gap between what we have and what we need, and asserted that the pressures for filling these needs are greater than ever before. In General Bragdon's opinion, the future of the civil engineer in the national picture is bright.

In the **New Mexico Section** the new panel is Ray J. Ross, president; Reuben E. Cole, first vice-president; Eugene Zwoyer, second vice-president; and Robert G. Dwyre, secretary-treasurer.

Problems involved in locating the Twin Cities Freeway were discussed at the **Northwestern Section's** November meeting. O. L. Kipp, special consultant and former chief engineer of the Minnesota Highway Department, was featured speaker. The Section's new life members are Dan S. Helmick and P. F. Huntington.

Unanimous choice of the **Oregon Section** for its 1957 officers is as follows: David Lewis, president; C. F. Craig, first vice-president; James Apperson, second vice-president; and John Collins, secretary. Highlight of the November meeting was an illustrated talk on the new Interstate Bridge being built across the Columbia River.

San Diego Section members attending the October meeting heard Neil Lamb, long-range planning director for General Dynamics at Convair, discuss Convair's long-range program as it relates to engineers.

In the **Seattle Section** the new slate is William Enkeboll, president; Thomas H. Campbell, vice-president; Leland L. Sphar, secretary; and John A. Peterson, treasurer.

The **Tri-City Section** has accepted the Illinois Section's invitation to take part in its preparations for the ASCE Convention in Chicago, which the Section is hosting in February 1958. Allen R. Boudinot is the Tri-City Section's new life member. At the October dinner meeting T. F. Taylor, area development engineer for the Iowa-Illinois Gas & Electric Co., presented "the dynamics of present-day progress" in a talk showing the relation between the labor market and the needs of industry.

NEW ARMCO GATES

meet water works and sewage plant needs

Now it is easier than ever for you to choose a gate to meet your needs.

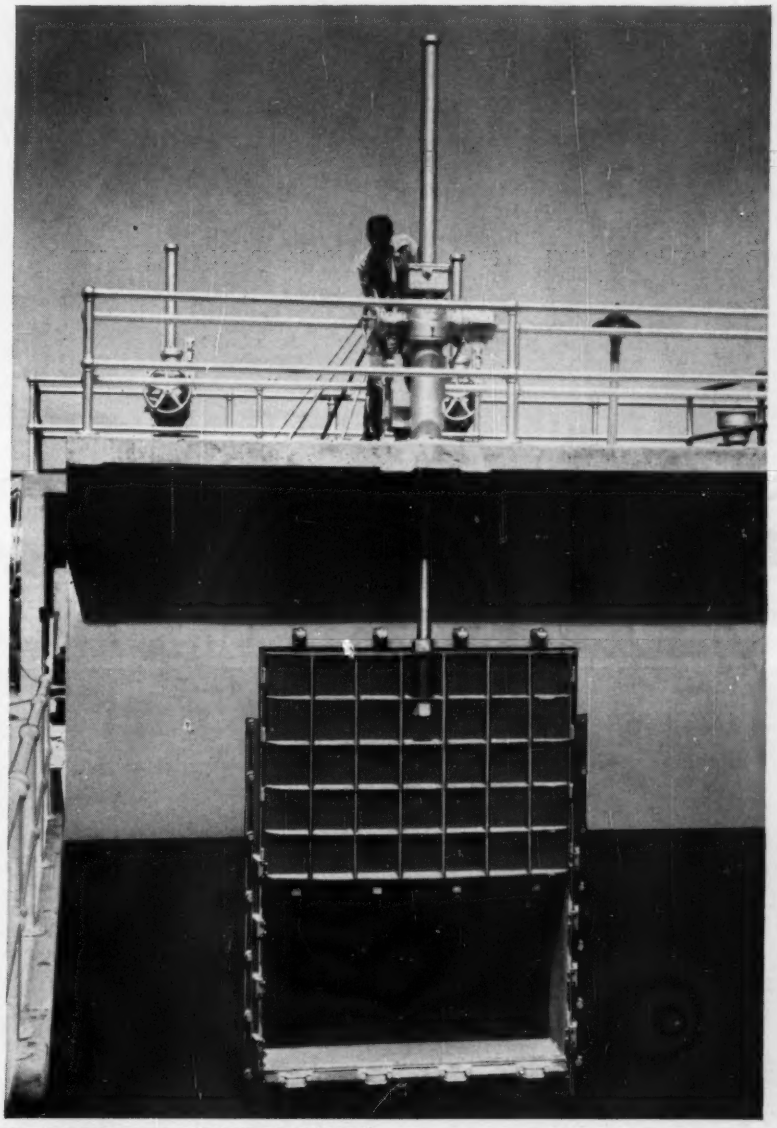
Armco has acquired the facilities for producing Pekrul Gates from the Morse Brothers Machinery Company of Denver. This well-known line, added to Armco's already wide variety of irrigation and water control gates, meets most water works and sewage plant requirements.

One-source supply saves time, trouble

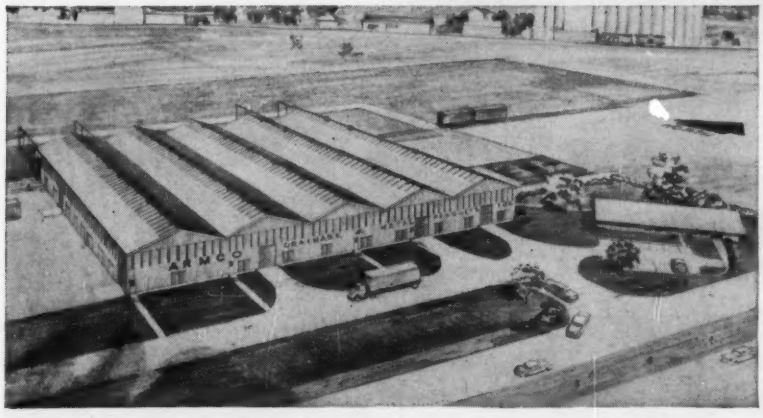
In addition, Armco supplies corrugated pipe for sewer lines in the widest variety of sizes, shapes and coatings, thus further simplifying your choice of the right product to do the job.

For water lines, Armco Welded Steel Pipe, widely used by municipalities and industry, will provide economical, trouble-free service.

For complete data on Armco Gates and other products for sewage and water control, see the Armco Sales Engineer in your area. Armco Drainage & Metal Products, Inc., 3427 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation. In Canada: write Guelph, Ontario. Export: The Armco International Corporation.

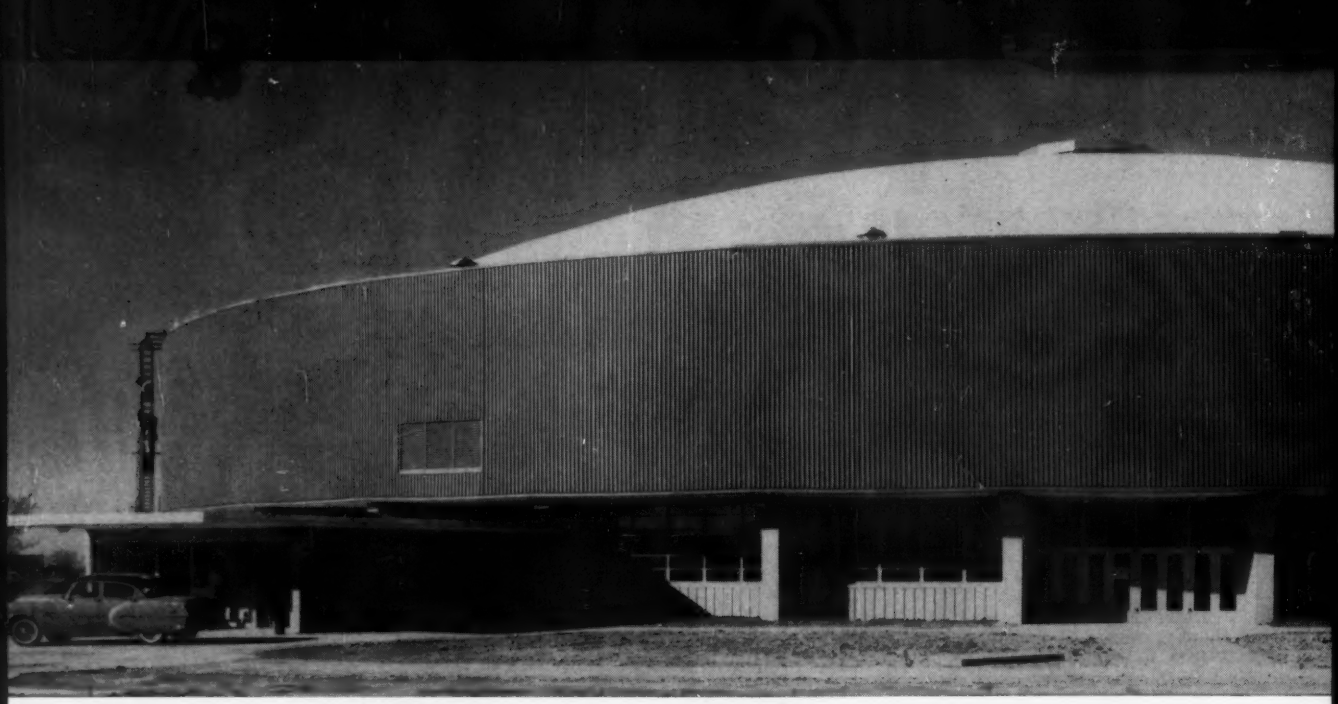


Here is one of the many gates, newly added to the Armco line, for efficient, economical sewage and water control.



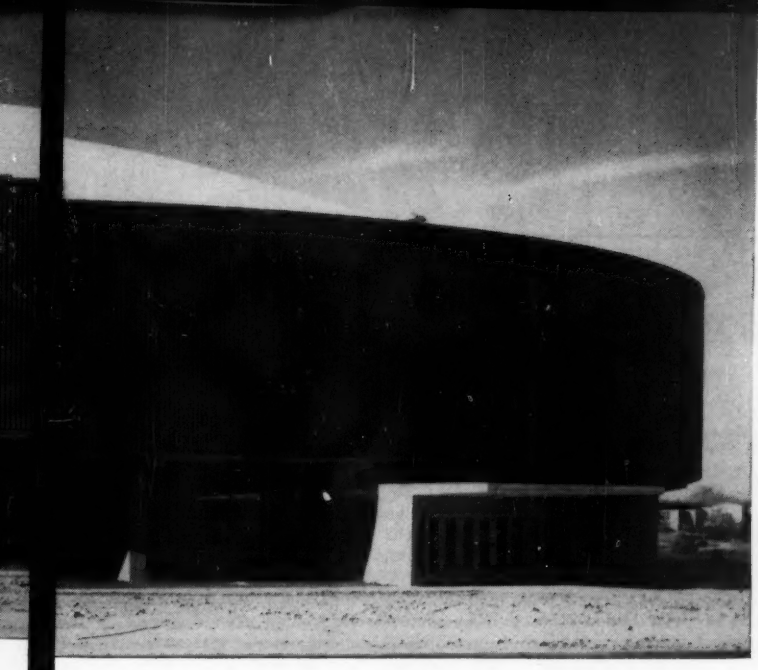
Architect's drawing of new Armco plant in Denver, where Armco Gates are produced.

ARMCO®

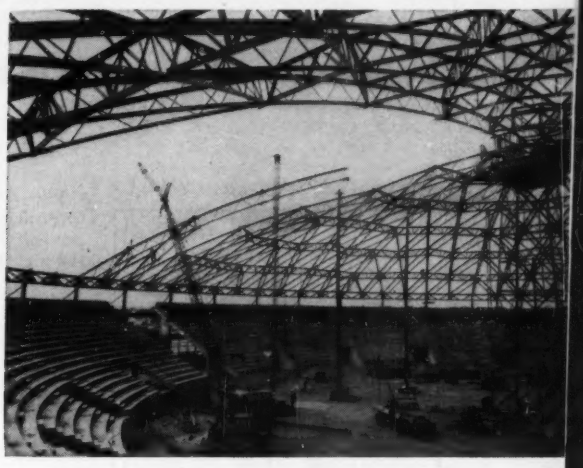


University of Wichita field house
features unique 267-foot diameter

THE ALL-WELDED, EXPOSED STRUCTURAL STEEL framework actually enhances the attractive interior of the building. The soffits of all trusses are painted a brilliant red which contrasts with the gray lead of the rest of the steel, emphasizing the diamond pattern.



UNIVERSITY OF WICHITA FIELD HOUSE. Architects: Lorentz, Schmidt, McVay, and Peddie, Wichita, Kansas. **Steel Fabricator:** Watkins Inc., Wichita. **General Contractor:** Dondlinger and Sons Construction Company, Wichita. **Designer and Engineer of Lamella Roof Structure:** Roof Structure Inc., Webster Grove, Missouri.



THE ROOF STRUCTURE is supported by 36 10WF39 columns. A trussed ring girder, 39 inches deep, rests on top of the columns and runs the entire perimeter of the building. Into this ring girder are framed 12 radial trusses which span to the compression ring at the apex of the roof. Also springing from the ring girder at intermediate points are curved roof trusses which intersect the radial trusses, resulting in the characteristic diamond-shaped lamella pattern.

lamella dome of Structural Steel

432 tons of steel erected in only 14 days

The unique lamella dome of Structural Steel which crowns the University of Wichita's new field house is the *first* such dome ever to be constructed. It was designed, developed and put to use for two practical reasons—economy and speed of erection.

Spanning 65,000 square feet, the 432 tons of Structural Steel were erected by two crews in the spectacular time of just 14 days! Starting on opposite sides of the building, the two crews worked around in one direction until closure was effected. The only falsework required was a central tower supporting the compression ring, or "lantern," at the apex of the dome. All connections were bolted during erection, then field-welded.

Built at a total cost of $1,405,700, the ultra-efficient structure includes such features as a complete heating and ventilating system (with radiant heating in the locker rooms), and color-corrected vapor lighting for the arena. And, with peripheral seating, not one of the 10,235 seats is more than 86 feet from the playing surface.

Where economy, speed of erection, and dramatic design are the keywords of construction, that's where you'll find versatile Structural Steel. Moneywise, Structural Steel is the most economical of load-carrying materials. And, it's the strongest. It will withstand more abuse than other structural materials, effectively resisting tension, torsion, compression and shear. Once enclosed in buildings, it lasts indefinitely, requiring no maintenance.

USS STRUCTURAL STEEL

6-2289-A

UNITED STATES STEEL

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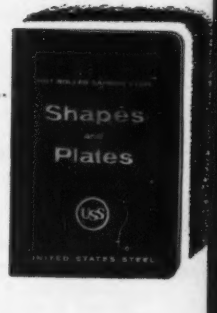

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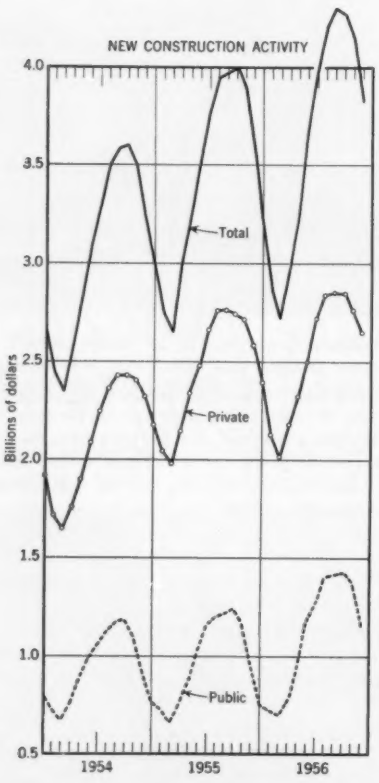
November Construction at High for the Month



November construction, at $3.8 billion, although down 8 percent from October, establishes new record for the month.

The $3.8 billion expended for new construction in November, although 8 percent below the previous month, was the highest for any November on record, according to preliminary joint estimates of the U. S. Departments of Commerce and Labor. On a seasonally adjusted basis, outlays for new construction were at an annual rate of $44.6 billion—the highest since July.

During the first eleven months of 1956, the new construction expenditures amounted to nearly $40.8 billion, topping by 3 percent last year's total of $39.7 billion for the same period and virtually assuring a new annual record of about $44.1 billion.

Private construction expenditures decreased 4 percent in November. The value of work put in place on new private housing declined seasonally (by 3 percent) from October to a level 11 percent below the November record of a year ago. Private office building, on the other hand, was at an all-time high. Industrial and religious building and utilities construction set new records for November.

All major types of construction contributed to the 16 percent decrease from October to November in public outlays. In most instances, however, the rate of decline was more moderate than the downturn usual at that time of year. Highway construction, public educational building, sewer and water work and public service enterprises registered a greater volume of work put in place than in any previous November.

Great Lakes Connecting Channel to Be Deepened

Apparent low bidder on the dredging work to be done in the Amherstburg Channel of the Detroit River—the first phase in the $150 million Great Lakes Connecting Channels deepening project—is announced by the Detroit District of the Corps of Engineers. Low bidder is the Marine Operators, a combine of four construction companies: Al Johnson Construction Co., of Minneapolis; Peter Kiewit Sons Co. and Cunningham Kiewit Co., of Omaha, Nebr.; and Morrison-Knudsen Co., of Boise, Idaho. The total low bid came to $18,338,145—$8,000,000 less than the next low bid.

The site of the work will be the Amherstburg Channel, the lower portion of the Detroit River, opposite the City of Amherstburg, Ontario. The project, which includes drilling and blasting, dredging, and the construction of compensating dikes, will be started next spring. The Great Lakes Connecting Channels deepening project is designed to accommodate the large ore and other bulk carriers being added to the Great Lakes fleet. It will also accommodate ocean vessels of any size entering the Lakes via the St. Lawrence Seaway. This overall project will be finished in 1962.

Three Assigned to Suez Canal Clearance

A three-man team has been appointed by Dag Hammarskjold, Secretary-General of the United Nations, to handle the task of clearing the Suez Canal. Lt. Gen. Raymond A. Wheeler, retired Chief of Army Engineers, was named to assist the Secretary General in the technical organization of the project. John J. McCloy, board chairman of the Chase Manhattan Bank, will advise on business negotiations, and Alfred G. Katzin, of the U.N. Secretariat, will assist the Secretary General within the Secretariat.

The cost of clearing the canal, which is blocked by a number of sunken vessels and destroyed bridges, is estimated at $40,000,000. Time estimates range from eighty days to six months.

E. H. Robie Retires as Secretary Emeritus of AIME

After 25 years in official capacities with the American Institute of Mining, Metallurgical, and Petroleum Engineers, Edward H. Robie retired the end of November as secretary emeritus. A member of the AIME since 1919, Mr. Robie became assistant secretary in 1932, secretary in 1949, and secretary emeritus in 1955. He is editor-in-chief of a new volume on mineral economics, which will be published in 1958.

Cuba to Be Mapped by Air

The Cuban government has just signed a contract in Havana for the air mapping of the entire island. The Aero Service Corp., of Philadelphia, will perform the survey, which will start at once and cost $1,100,000. Covering some 45,000 sq miles, the survey will be one of the largest topographic mapping projects ever undertaken by aerial photogrammetric methods.

According to Aero Service engineers, 324 map sheets, each 20 by 15 in., will be compiled to cover the complete area. The contract calls for 5,500 copies of each map sheet, or a total of 1,663,000 six-color maps. First maps will be delivered late in 1958, and the entire project completed in 1959. It is estimated that over forty years would be needed to map Cuba by ground survey methods.

New Officers Installed at ASME Annual Meeting

William F. Ryan, vice-president, director, and senior consulting engineer of the Stone & Webster Engineering Corp., Boston, was installed as president of the American Society of Mechanical Engineers at the annual meeting of that organization, which was held in New York late in November. Also installed were Technical Director Eugene W. Jacobson, chief design engineer of the Gulf Research and Development Co., Pittsburgh, and Administrative Director V. Weaver Smith, vice-president in charge of contracts for the Lummus Co., New York, N. Y.

Named as regional vice-presidents were William H. Byrne, president and chairman of the board, Byrne Associates, Inc., New York; James H. Sams, dean of engineering, Clemson College, Clemson, S. C.; Rolland S. Stover, owner of R. S. Stover Co., Marshalltown, Iowa; and Clifford H. Shumaker, chairman of the Department of Industrial Engineering, Southern Methodist University, Dallas, Tex.

Joseph W. Barker, M. ASCE, outgoing president of the ASME and a leading research executive, called on American industry to throw its weight behind the engineering and science schools of the nation. "Such support of engineering and science education is less of a gamble with stockholders' money than is the support of research," Dr. Baker asserted. He also urged that salaries of engineering and science teachers be brought to levels reasonably comparable with industrial salaries for persons of equivalent capabilities and attainments.

Walt Whitman Bridge to Open Next Spring

Construction of the $90,000,000 Walt Whitman Bridge across the Delaware is proceeding on schedule, and indications are that it will open early next spring. The 6.5-mile structure will connect industrially important southeast Philadelphia (at Twenty-eighth Street) with the Black Horse Pike in Haddon Township, N. J. It will also link the Schuylkill Expressway, currently under construction through Fairmont Park in Philadelphia, and the north-south freeway being built by the New Jersey State Highway Department.

With a main span of 2,000 ft, the Walt Whitman Bridge will be the seventh largest suspension bridge in the world. The side spans, from towers to anchorages, are each 770 ft long. In its 79-ft width the new structure will accommodate seven traffic lanes, which can be reversed as traffic warrants to provide as many as five lanes in one direction. All seven lanes are wider than average to allow more room for the new wider cars.

The structure is being built by the Delaware River Port Authority, which will operate it as a toll crossing, as it does the Benjamin Franklin Bridge. The designing engineers were a combine of Modjeski and Masters and Ammann & Whitney.

An article on the anchorages and superstructure was published in the February 1956 issue (page 52).

Beavers Schedule Second Award Dinner

Abel Wolman, M. ASCE, professor of sanitary engineering at Johns Hopkins University and former president of the American Water Works Association, will be featured speaker at the second annual awards dinner of the Beavers, to be held January 17 at the Biltmore Hotel in Los Angeles. Dr. Wolman's subject will be "So-called Useless Knowledge."

At the dinner special awards for outstanding contributions and meritorious service to the heavy construction industry will be presented to eleven persons whose names will not be revealed until the actual moment of presentation. R. F. Rasey is chairman of the Awards Committee.

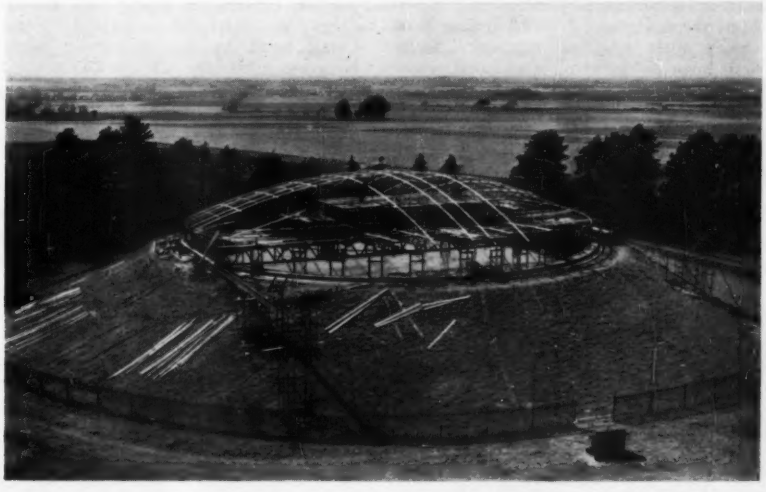
New York City to Have New 60-Story Building

Plans for an ultramodern 60-story office building—to be erected on the east side of the Avenue of the Americas between 51st and 52nd Streets in mid-Manhattan—are announced by Peter B. Ruffin and John W. Galbreath, real estate developers. With the 60-story Chase Manhattan Bank structure, to be started soon in the financial district, the building will be the tallest skyscraper put up in New York since the erection of the 65-story R.C.A. Building a generation ago.

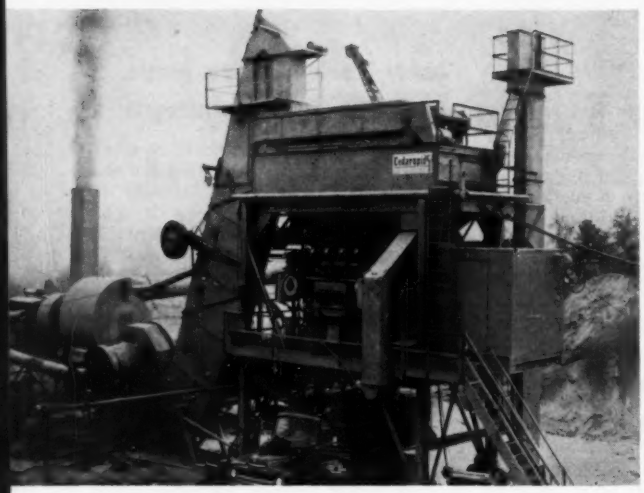
With a gross area of 2,000,000 sq ft and about 1,700,000 sq ft of rental space, the new structure will be the city's fourth largest building. Its facade will be stainless steel. An unusual feature in a building of such size is that the tower, which will extend from the fifteenth to the sixtieth floor on the side streets and from the third to the sixtieth floor on the avenue, has been designed to eliminate interior columns. A 40-ft plaza on the avenue side will be planted with trees and shrubs. Three setbacks will assure good light.

Harrison & Abramovitz are the architects; Edwards & Hjorth the structural engineers; and Jaros, Baum & Bolles, the mechanical engineers. The building contract has been awarded to the Turner Construction Company.

Self-Supporting Aluminum Roof for Reservoir



Domed, self-supporting aluminum roof, 125 ft in dia. is being erected over old Toplers Hill Reservoir, Bedfordshire, England. The method of construction permitted building the roof without draining off the water. As shown, circular ring beam takes the thrust of the hollow box-section ribs. Aluminum alloy sheets, 16 gage, cover the ribs. Roof was designed and erected by Aluminum Construction Ltd., Banbury, Oxfordshire, which has also erected a similar roof of 150-ft span containing 23 tons of aluminum. Spans up to 500 ft are contemplated.



The trend to greater production, the key to modern road building, is exemplified by this Cedarapids automatic batching plant which can load 30 six-ton trucks per hour with bituminous paving material. Multiple use of equipment is another hallmark of modern construction. A mile a day of 2½-in. pavement is laid by these three Barber-Greene asphaltic concrete pavers (shown in right-hand view) operating in tandem.

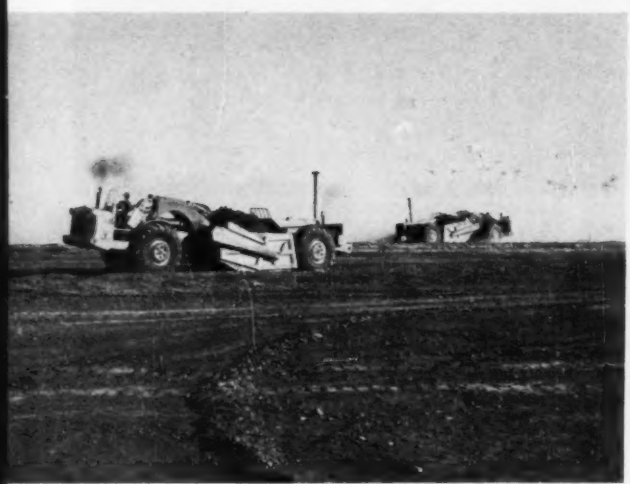
A Decade of Development in Road Equipment — Chicago

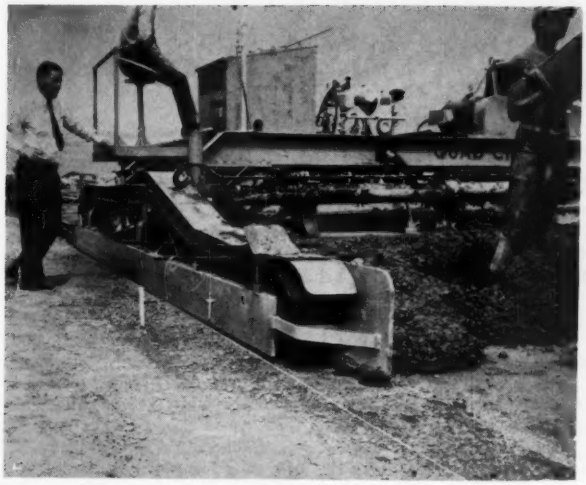
Rumblings from the forthcoming ARBA Road Show, to be held in Chicago, January 28-February 2, serve to focus attention on the changes in construction equipment that have taken place in the past ten years. The numerous small developments that have been incorporated in road-building machines with startling regularity have added up to an astounding total since the last show in 1948. These developments have taken two prominent directions—greater productivity and more machines to do specialized jobs. Among the more eye-catching changes has been the introduction of bigger crawler tractors weighing over 25 tons and having over 300 hp. In 1948 the largest crawlers had about 130 drawbar hp; today comparable models are up to 155 to 160 dbhp. Two-wheel and four-wheel tractors today boast up to 50 percent more horsepower. Where 500 to 600 tons a day was standard for asphalt-mixing plants seven years ago, 1,200 tons is not uncommon today.

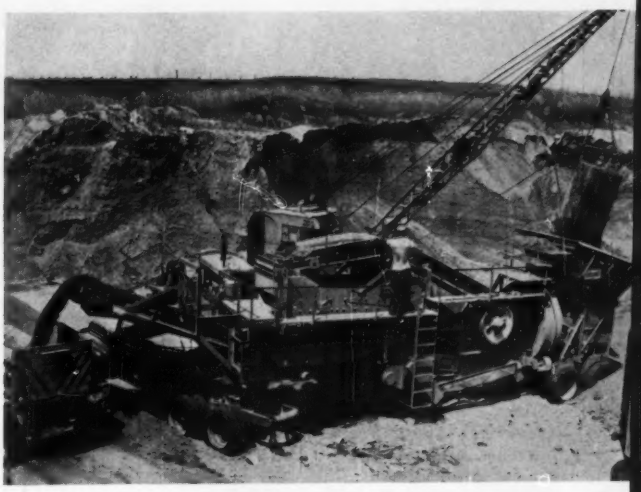
Along with stepped-up horsepower and capacity, speed of operation has also been revised upward. Ten years ago rubber-tired scrapers were used primarily on long-haul jobs. They were a specialized tool. The crawler-tractor scraper was the general tool. Today rubber is the heart of the scraper operation. Where the going is tough pusher loading by tracked tractors is the answer, but the rubber-tired tractor-scraper may become the primary grading tool.

With the present great expansion of

Euclid self-loading 18-cu yd scraper has twin engines driving separate axles. One machine replaces two or more, a particular advantage in confined areas. Twin engines deliver 514 hp. Bigness marks today's off-the-road construction machines. Ten years ago the principal truck sizes were 12 to 18 tons. The Euclid rear dump pictured is a 50-ton machine.







Dramatic developments of the past decade include the advent of the formless paver. Portable aggregate plants now account for about 85 percent of the aggregate used in road building. Cedarapids machine can produce 200 tons of selected gravel per hour. One of these massive units is pictured in view at right.

Road Show, January 28 – February 2

the primary road system, much work will necessarily be done on the secondary and feeder roads. Since 1948 complete lines of road-widening equipment have been developed. There are special machines for bringing subgrades to a close tolerance and small cranes for the placement and removal of side forms of pavements.

These are but a few examples of how far we have come in a decade. The advances are the result of the tremendous economic pressures of the toll-road boom of this period. Contracts have grown larger and larger, time limits have grown shorter, and competition has been stiff. Road-building machines have had to produce more. The economic pressures of the next decade if anything will be even greater. Many more miles of roads will be built at an even faster rate. The machines on exhibition at the coming Road Show are only the beginning of lines of high-production equipment that will appear on the road-building scene in the next few years.

Another machine gaining in popularity by leaps and bounds is the front-end loader. Here loader handles aggregate for loading onto truck. It is useful for backfilling trenches.

Motor graders have grown along with the rest of the heavy equipment lines. This Galion grader weighs 28 tons and boasts 230 dbhp. Versatility is another characteristic of modern road-building equipment. Machines such as Gradall shown (at right) can be used on many phases of a project, ranging from trenching to work on high embankments.

Construction to Continue at Record Levels in 1957

Outlays for new construction are expected to total almost $46½ billion in 1957—an increase of about 5 percent above the record volume of more than $44 billion apparent for 1956. This is the consensus of joint outlook estimates prepared by the Departments of Labor and Commerce. The anticipated volume is based on the assumption of a moderate advance in economic activity, with employment continuing at record levels and personal income reaching a new high. It is also assumed that there will be no drastic change in the international situation.

The joint agencies foresee some expansion in most major types of construction with the exception of new private housing. Because of the housing decline private construction activity as a whole is expected to show only a nominal increase over this year's level, reaching a total of $31.4 billion in 1957. However, public construction outlays are expected to increase a substantial 13 percent, to $15 billion. Physical volume (expenditures adjusted for price changes) may also be up slightly from 1956, and will about equal the record set in 1955.

It is expected that construction costs will continue to rise, but at a rate slightly lower than in 1956. As the joint agencies see it, building materials generally should be in adequate supply, because of extensive gains in plant capacity and record production levels. However, minor spot shortages are a possibility. Mortgage funds will probably continue to be relatively scarce, especially for long-term, low-down-payment loans, reflecting widespread competition for credit.

Prospects are that about a million new private non-farm dwelling units will be started next year, compared with an average annual rate (seasonally adjusted) of 1,100,000 for the first ten months of 1956 and a 1955 total of 1,310,000. The value of this work is likely to be around $14¾ billion, about 3 percent below the 1956 volume.

Most of the gain in private construction outlays is anticipated on the basis of increased construction activity by the public utilities, with announced expansion programs suggesting unprecedented expenditures of about $5¾ billion in the field. The most significant construction gains will probably be in natural gas pipelines and electric power facilities. Present indications are that private industrial plant construction will continue to expand in 1957, but at a much slower rate than during the past two years. Commercial building is expected to remain unchanged from this year's record level, with increases in office building offsetting a decline in expenditures for new stores and other mercantile buildings. Total outlays will probably be $3.3 billion.

Anticipated increases in public construction activity are based on continued expansion in all types of state and local public works, especially highways, schools, and sewer and water facilities. A backlog of needs in all these categories still exists. The expanding highway program will probably bring construction in this field to a new high of $5½ billion, or about 8 percent above this year's level. To provide essential community services for new housing developments and continually growing suburbs, record expenditures of nearly $2.9 billion for public school building appear likely in 1957, and the value of new sewer and water facilities construction is expected to be more than $1½ billion for the first time.

Construction work at military bases will be at a postwar high. Outlays for public housing will show the first significant expansion since 1951, primarily because of the new federal program of military housing. Finally, construction and development work is expected to increase for the second successive year, when projects such as the Oahe Reservoir on the Missouri and channel development of the St. Lawrence are at peak.

Jacks Keep Bank Vault from Sinking on West Coast Bank Project

Contractors at work on the new San Francisco International Airport, which is being built in a filled-in area in San Francisco Bay, must cope with the fact that buildings not on pilings are expected to settle 20 in. in the next four decades. Here the adroit use of jacks solves one of the worst problems, which was encountered by the Bank of America in building its branch office at the airport. Soil investigation showed that the 150-ton vault would settle more than the rest of the structure, making a 10-in. difference between the two parts of the same building. Four 100-ton Duff-Norton 126 RX air-motor-powered screw jacks were used to "float" the heavy vault and keep it in line. Each weighs 448 lb and stands 26 in. high, and can raise 75- to 100-ton loads 14 in. in a few minutes. The vault was built separately from the building proper, but adjoining it on two sides. Spirit levels set in the walls show when the vault has shifted. The jacks can then be activated by control valves, and the vault returned to the desired position. The Continental Service Co. is credited with the decision to use the jacks, which were placed by the firm of Johnson and Mape, Menlo Park, Calif.

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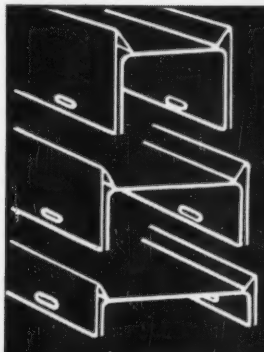

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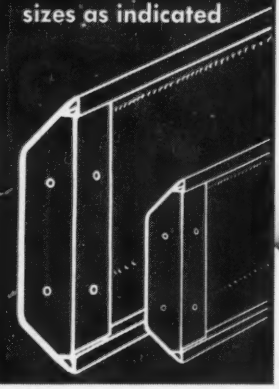

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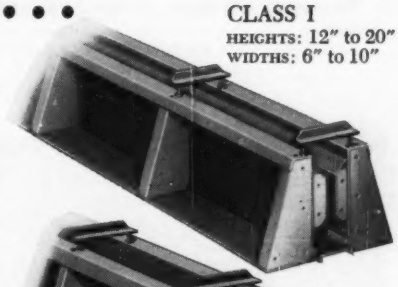
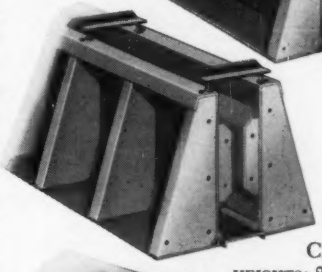
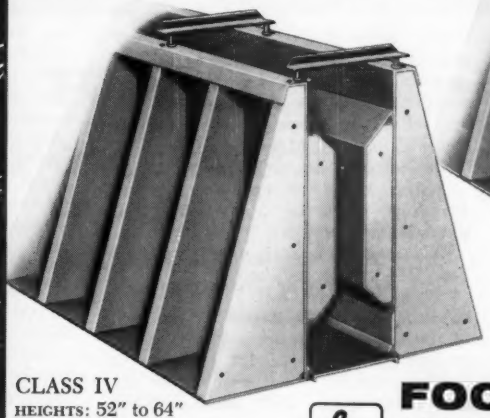




CLASS II
HEIGHTS: 20" to 32"
WIDTHS: 8" to 12"

CLASS III
HEIGHTS: 36" to 48"
WIDTHS: 14" to 18"



CLASS IV
HEIGHTS: 52" to 64"
WIDTHS: 20" to 24"

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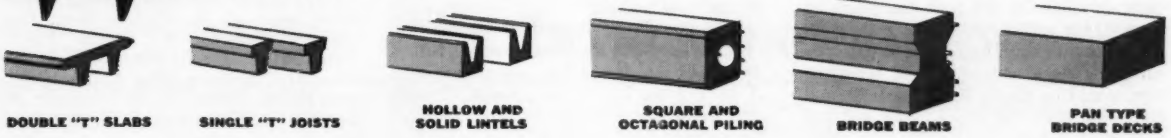

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Fabric-in-Asphalt Used for Resurfacing Bus Stop

Port of New York Authority has completed resurfacing with fabric-in-asphalt its heavily traveled north passenger bus stop on the George Washington Bridge. Here worker (at left) is fastening fabric sheets together with hog ring on longitudinal wires. The sheets are fastened in several places across their width to assure continuity of reinforcing. The sub-base has been covered with 1-in. leveling course of asphaltic concrete (compacted), and part of the wire fabric has been placed and covered with 2 in. of binder course (foreground). Worker, at right, is hand-spreading binder course. Anthony Grace and Sons, Inc. Whitestone, N. Y., held contract for the project. Reduced maintenance was a prime factor in selection of fabric-in-asphalt for the resurfacing project due to the heavy volume of bridge traffic—as high as 130,000 vehicles.

AIME Names New Officers

Following a recent meeting of its board of directors, the American Institute of Mining, Metallurgical and Petroleum Engineers has announced the election of Augustus B. Kinzel, of New York, as president for one year beginning February 1958. Dr. Kinzel is vice-president of the Union Carbide and Carbon Corp. in charge of research. Others elected to take office in 1958 are Vice-Presidents Edmund C. Babson, of Calgary, Alta., and Roger V. Pierce, of Salt Lake City.

Grover J. Holt, of Ishpeming, Mich., now president-elect, will serve as president in 1957, taking office February 26 at the annual meeting to be held in New Orleans. Carl E. Reistle, Jr., of Houston, Tex., is currently president.

Need for Billions in Public Works Is Cited

The nation's public works needs were put at $200 billion by President Eisenhower's special assistant for public works, Maj. Gen. J. S. Bragdon (retired), in a recent talk before the nation's mayors. Addressing a business session of the American Municipal Association's thirty-third annual congress, held in St. Louis in November, General Bragdon said that this amount of new construction will be needed to bring state and municipal public facilities up to date. He explained that $92,000,000,000 is needed for highways; $41,500,000,000 for education; $22,000,000,000 for water and sewage disposal; and $23,200,000,000 for other facilities.

The present rate of state and city construction would have to be more than doubled for the next ten years to meet these estimates, General Bragdon warned. He noted that 1955 expenditures for state and municipal construction would be about $12,500,000,000, and estimated that this year's figure will run somewhat higher.

N. G. Neare's COLUMN

R. ROBINSON ROWE, M. ASCE

"My only New Year's resolution," confided the Professor, "was to take it easy in 1957. Tonite, for instance, I'm going to let Guest Professor Gorithm unravel his problem of the concrete samples for the Minnekota Turnpike. Wake me up when you're thru, Al."

"Better keep one eye open, Noah. Joe Kerr might be funny when Cal shows him up."

"This time I'll fool you," promised Joe. "Besides, Cal isn't here."

"Then McTavish will. He's here, and he's the Resident's assistant who had to use the public scale at $1.00 per tag to find the weight of 121 cylinders in 6 lots, some of which were cured dry and some moist. How much did he have to pay?"

"Not $121. He'd be pretty dumb to haul more than one sample from each lot, and if I know McTavish, he'd get his $6 back from the gold bricks who forgot to mark the curing on the sample tags. So I'd say McTavish *advanced* $6 and *paid* nothing!"

"Thanks, Buster," burred McTavish. "Ken ye nicht the lots ranged from 10 to 50? An' if the lots are marrucked A to F from big to wee, A=50, F=10 and the 4 ithers add to 61. Now B may be as larrudge as 31 if C=D=E=10, but nicht sa wee as 15. Ye micht ha' ken these limits for all lots:

Lot	Min	Max	Weigh
A	50	50	32
B	16	31	16
C	10	20	8
D	10	17	4
E	10	15	2
F	10	10	1

"The last column is a' ta weigh from ary lot, 63 in a', an' a' weighed tagither. Sh'd a' be drrhy, the tag'd be 1890 lb, or 1953 sh'd a' be wet, ye ken, an' ary ither weight kens ye the wet frum the drrhy."

"What Mac means," explained the Guest Professor, "is that any number from 1 to 63 can be expressed in just one way as the sum of powers of 2, including $2^0=1$. If the weight tag read 1915, the excess over 1890 would have been 25. This being 11001 in the binary system, lots B, C and F would have weighed 31 lb per cylinder and the others 30 lb. And you only paid a dollar, Mac?"

"Aye."

"And if there had been only 15 samples in Lot B, you would have paid $2.00?"

"Aye."

"Are you awake and watching Joe, Noah?"

"Aye. I mean 'Yes'. Joe's face looks like he'd just swallowed a concrete cylinder, a 31-pounder. I think he'd like another chance, so let's confuse him with a sequel. Suppose there had been 49 samples in 7 lots of 7 each, how much would it have cost to separate the wet-cures from the dry?"

[McTavishes and other binary enthusiasts were: R. E. Philleo, Sauer Doe (Marvin Larson), H. Francis Finch, Commen Sense (H. Kane and R. M. Barnoff), Thachrite (Guy C. Thatcher), and Julian Hinds. Guest Professor Al Gorithm was (or were) L. E. Goodman and A. R. Robinson.]

When completed in 1957, glamorous Habana Hilton Hotel will cover a full city block and be Cuba's largest. Resting on a firm INTRUSION-PREPAKT foundation, it will have 630 rooms in its 22 stories and be completely air conditioned.

Owner: Federation of Culinary Workers of Cuba
Agent and Contractor: Frederick Snare Corporation
Consulting Foundation Engineers: LeRoy Crandall & Associates and Prof. Jose Menendez

Unretouched photo shows how porous Pleistocene coral (white) was filled with INTRUSION grout (gray). Over one million gallons of INTRUSION grout were pumped into hotel foundation.

newest Hilton hotel rests on grout-intruded coral

INTRUSION-PREPAKT grouting techniques have assured a strong, stable foundation for the Habana Hilton now under construction in Havana, Cuba. The porous coral rock under this $14 million structure was strengthened by pumping some 147,000 cu. ft. of INTRUSION grout.

Faced with a foundation material that could not take the footing pressures, Consulting Engineer Jose Menendez called in INTRUSION-PREPAKT. With their extensive experience in foundation stabilization, I-P engineers demonstrated that grouting would provide the best and lowest cost answer to the problem.

All grouting work was done by trained INTRUSION-PREPAKT crews and completed on schedule. The use of INTRUSION grout with its high strength, excellent penetrability and ease of handling assured that all voids would be filled and maximum strength developed.

When difficult foundation problems arise, perhaps you, too, can save time and money with INTRUSION-PREPAKT methods and materials. For information, contact: INTRUSION-PREPAKT, Inc., Room 568-B, Union Commerce Building, Cleveland 14, Ohio. In Canada: INTRUSION-PREPAKT, Ltd., 159 Bay St., Toronto, Ont.

INTRUSION-PREPAKT, INC.

OFFICES IN PRINCIPAL U. S. AND FOREIGN CITIES

Intrusion and Prepakt are trade marks of Intrusion-Prepakt, Inc., whose methods and materials are covered by U. S. Patents Nos. 2313110, 2655004, 2434302 and others, also patents pending.

DECEASED

Farrand Northrop Benedict (M. '17), age 76, for 46 years vice-president and chief engineer of the Thomas Crimmins Contracting Co. of New York City, died recently in Parsippany, N. J. A graduate of Phillips Andover Academy and Columbia University School of Engineering, Mr. Benedict worked for the New York & Long Island Railroad Co. and the St. John Clark Co. in New York for several years. He joined the Thomas Crimmins Contracting Co. in 1909 as engineer, and from 1913 until recently had been vice-president and chief engineer.

Wallace B. Boggs (M. '35), age 64, retired county surveyor and road commissioner of Alameda County, died at his home in Oakland, Calif., recently. Mr. Boggs was a 1912 civil engineering graduate of the University of California. For a number of years he maintained a consulting practice in Oakland. Earlier he was chief engineer for the Joint Highway District 13, Oakland, on tunnel and highway design and construction.

Grover Charles Brown (M. '20), age 73, retired secretary of the Industrial Relations Committee of the American Iron and Steel Institute, died recently in Palisade, N. J. Mr. Brown retired three years ago after twenty years with the Institute, during which he handled all phases of industrial relations activities for members of the iron and steel industry, and was adviser to iron and steel industry employers delegates from the United States at conventions of the International Labor Organization. From 1917 to 1933 he was chief civil engineer, management representative in industrial relations, and manager of training for the Bethlehem Steel Company at Johnstown and Bethlehem, Pa. He graduated from Cornell with a C. E. degree in 1906 and an M.C.E. degree in 1909, and held a graduate fellowship in civil engineering.

Charles R. Burdett (M. '28), age 66, Major, U. S. Army Corps of Engineers (retired), and for the past three years structural engineer for the State of Maryland, died recently at his home in Baltimore. Mr. Burdett had been a structural engineer in the Procurement Division of the Public Building Branch of the Treasury Department, and for seventeen years was with the Herman F. Doleman consulting firm in Baltimore. A veteran of both World Wars, he served in the recent war as major and special assistant to the district engineer at Norfolk, Va., remaining in this capacity until his retirement in 1953.

Peter D. Dal Pizzol (J.M. '54), age 24, private first class, U. S. Army Medical Corps, Fort Devens, Mass., was killed in an automobile accident in Grafton, Mass. Mr. Dal Pizzol was a civil engineering graduate of City College of New York, class of 1954. He was associated with the Klevens Corporation, Yonkers, N. Y., working on the New York State Thruway Bridge at Suffern, N. Y., before his induction into the army.

Peter Dal Pizzol

Edwin Leslie Davis (A.M. '24), age 62, engineer and vice-president of the firm of Davis, Wick and Rosengarten, Washington, D. C., contractors, died suddenly on November 7, after leaving his office. His home was at Rockville, Md. Mr. Davis became connected with the firm Davis, Wick and Rosengarten in 1925, holding the positions of engineer and secretary. Earlier he had been an engineer with the Washington, D. C., firm of William P. Lipscomb Co., Inc. He was a 1917 graduate of the University of Pennsylvania and a veteran of World War I.

William Henry Evers (M. '26), age 85, retired consulting engineer of Cleveland, Ohio, died recently at his home in Florida. He was president of the Cleveland consulting firm of William H. Evers & Associates from its formation in 1926 until his retirement five years ago. The company specialized in municipal, structural, and highway engineering, sanitary work, and reinforced concrete retaining walls and steel revetments. Earlier he had been president and consulting engineer of the R. C. Products Co., of Cleveland, and consulting engineer for the Spokane Silver & Lead Co., Custer, S. Dak.

Morton M. Flint (M. '51), age 50, newly appointed head of the Bureau of Public Roads in Alaska, died suddenly at his home in Sacramento, Calif., on November 10. Mr. Flint had just returned from Alaska and was completing arrangements for moving his family to Juneau. Until recently he was assistant division engineer for the Bureau at Sacramento, and earlier had been district engineer at Missoula, Mont., and construction engineer and assistant chief engineer in Alaska. He joined the bureau of Public Roads in San Francisco shortly after his graduation from Stanford University in 1929.

Albert Freitag (A.M. '28), age 67, retired locating engineer with the Arizona State Highway Department, recently died at his home in Mesa, Ariz. A graduate of the University of Nebraska, class of 1913, Mr. Freitag spent most of his career in highway construction. He had been with the Arizona Highway Departmen for many years. Earlier he was associated with the Utah State Highway Department, and from 1935 to 1941 was associate agricultural engineer with the U. S. Soil Conservation Service in Arizona. A veteran of both wars, he served during World War II as a captain in the Army Corps of Engineers.

Victor T. Givotovsky (M. '42), age 63, acting director and chief of the Structural Division of the District of Columbia Municipal Architects Office, died recently. A graduate of Massachusetts Institute of Technology, class of 1919, Mr. Givotovsky spent the next eleven years as a structural and construction engineer in New York. He joined the District government as a structural engineer in 1931, working his way up to deputy director of the Buildings Department in 1953. Mr. Givotovsky supervised the structural design of all department projects for the past fifteen years. His most recent project was the new psychiatric building at the Washington, D. C., General Hospital.

Warren Esterly Hall (M. '32), age 75, retired hydraulic engineer, died recently at his home at New Smyrna Beach, Fla. From 1935 until his retirement in 1950 Mr. Hall was hydraulic engineer with the U. S. Bureau of Fish and Wild Life. For a number of years earlier he had been a member of the Atlanta, Ga., firm of B. M. Hall & Sons, specialists in dam design and construction. In his earlier career he was with the U. S. Geological Survey. In World War I Mr. Hall served overseas as major in the Corps of Engineers. He was educated at Georgia Institute of Technology.

Charles R. Harte (M. '07), age 86, retired civil engineer with the New York, New Haven and Hartford Railroad and its subsidiaries, died at his home in New Haven, Conn., on November 13. Mr. Harte joined the line in 1893 after his graduation from Columbia University, and from 1910 until his retirement in 1947, he was assigned to the Connecticut Company, a railroad subsidiary operating in New Haven, Hartford and other cities. During World War I he was engaged by the War Department to map electric railway tracks in a wide belt along the coast to expedite moving men and equipment in case of enemy attack.

Andrew Hall Holt (M. '31), age 66, since 1937 head of the Department of Civil Engineering at Worcester Polytechnic Institute, died at his home in Worcester, Mass., on November 22. A graduate of the University of Vermont's Engineering College in 1912, he received his master's degree from the University of Iowa in 1920 and a law degree in 1931. Professor Holt began his teaching career at the University of Vermont in 1912, and from 1914 to 1937 was at the State University of Iowa. He served in World War I as a major in the Corps

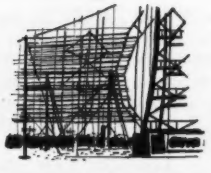
(Continued on page 104)

Consider Roebling First

. . . when you consider a suspension system of <u>any</u> kind!

Across Kootenay Lake in British Columbia stretches one of the longest single suspension spans in the world. Roebling fabricated the high-strength conductors. Two miles in length, it is part of an 87-mile power transmission line connecting the power plants and mine of Consolidated Mining and Smelting Company of Canada, Limited

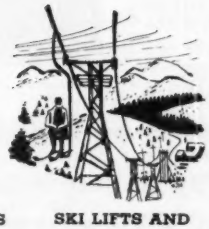
All structures and systems supported by wire members are of interest to Roebling, whose activity in this field goes back many, many years and is steadily increasing in scope. Some of the suspension applications on which Roebling has served in whole or in part are shown here. Within each of these categories, new concepts of design and operation do and *can* exist.



ANTENNA SYSTEMS

SELF-PROPELLED CARS

AERIAL TRAMWAYS



SKI LIFTS AND CHAIR LIFTS

PIPELINE BRIDGES

Thus, whatever your present problems are—or might be—in moving people or materials of any kind, or whatever "rivers" you contemplate crossing, you will do well to enlist Roebling's assistance and incomparable experience. An inquiry to John A. Roebling's Sons Corporation, Trenton 2, New Jersey, makes suspension system cooperation immediately available to you.

ROEBLING

Subsidiary of The Colorado Fuel and Iron Corporation

Deceased

(Continued from page 102)

of Engineers and in World War II as colonel. Professor Holt was the author of numerous articles and contributed technical papers to ASCE publications.

Julian Greenway Huckins (M. '46), age 60, chief of the Relocation Branch of the Engineering Division of the Corps of Engineers at Kansas City, Mo., was killed in an automobile accident on October 2. He was on his way to a conference connected with the relocation of private and public utilities involved in the building of Tuttle Creek Dam. Mr. Huckins had been with the Corps since 1941—first at Charleston, S. C., and since 1944 at Kansas City. From 1930 to 1941, he was resident engineer for the Public Roads Administration at Denver, Colo., on the Forest Highway System. He was a 1923 graduate of the Missouri School of Mines and Metals.

Horace S. Hunt (M. '19), age 73, president of Fargo Engineering Company, Jackson, Mich., died on November 10. Mr. Hunt joined the Fargo Engineering Company after graduating as a civil engineer from Michigan State University in 1905. From 1910 to 1941, he was superintendent of construction on steam and hydroelectric power plants for the Eastern Michigan Power Company and the Detroit Edison Company. He returned to Fargo in 1914 as a member of the firm, becoming president in 1925. Mr. Hunt was connected with the design and construction of numerous hydroelectric projects and had been consulting engineer on dams and hyroelectric plants for the Lower Colorado River Authority of Texas, the Central Nebraska Public Power and Irrigation District, and the Vicksburg and Tulsa Districts of the Corps of Engineers, and on special valuation matters to the TVA.

Leander Larson (M. '41), age 78, Lieutenant Colonel, U. S. Army (retired), died at his home in Lakeland, Fla., recently. Colonel Larson began his career as a sanitary inspector with the Isthmian Canal Commission in 1905 and two years later was made sanitary inspector in direct chrage of sanitation of Colon, Cristobal and Mt. Hope, Panama. In 1917 he left for wartime service in the U. S. Army Sanitary Corps as a captain and remained to serve in the Quartermaster Corps until his retirement in 1943. Colonel Larson had responsible charge of the building and enlarging of army installations all over the country and in the Philippines.

Lawrence E. Miller (A.M. '54), age 51, partner in the Cleaver Construction Co., general contractors of Akron, Ohio, died recently. Mr. Miller joined the Cleaver Construction Co. in 1943 as superintendent of construction and became a partner in the firm in 1946. Earlier he was superintendent of construction for the Ruhlin Contruction Co. of Akron; engineer in charge of estimating and concrete construction for the E. Alessio & Sons firm of Akron; and assistant engineer for the Ohio Department of Public Works. Mr. Miller received his civil engineering degree from the University of Akron in 1931.

Constantine A. Novie (A.M. '45), age 68, retired associate engineer with the Corps of Engineers, died at his home in Seattle, Wash., recently. A native of Russia, Mr. Novie was a graduate of the Institute of Technology of Tomsk, Russia, with a mining engineering degree. Prior to coming to the United States in 1923, he was engaged in the metallurgy industry. Mr. Novie had been with the Corps of Engineers until his retirement in 1951.

Angelo Peruch (J.M. '52), age 31, field engineer with Kaiser Engineers, Oakland, Calif., died recently of bulbar polio at his home in Mountain View, Calif. He was a graduate of Stanford University, class of 1952. Prior to his connection with Kaiser Engineers, Mr. Peruch was with Peter Kiewit Sons' Co. at Oakland and the E. V. Lane Corp. at Palo Alto.

Lewis A. Pick (M. '49), age 66, Lieutenant General, U. S. Army Corps of Engineers (retired) and Chief of Engieers from 1949 to 1953, died in Washington, D. C., on December 2. General Pick, who retired in February 1953, had served in the Corps of Engineers for thirty-six years. He was a 1914 graduate of Virginia Polytechnic Institute with a civil engineering degree and worked as a civil engineer with the Southern Railroad until 1917 when he joined the Army. He was particularly noted for his co-authorship of the Pick-Sloan Plan for the integrated development of the Missouri River Basin and as wartime builder of the Ledo-Burma Road —a feat that contributed to the winning of the war in the East. Later General Pick was responsible for the tremendous construction feat of building Thule Air Force Base in northern Greenland. At the time of his retirement he became vice-chairman of the Georgia Pacific Plywood Co., and in 1955 was appointed chairman of the board of directors of the John J. Harte Co., of Atlanta. He was also director of the State of Alabama's Planning and Industrial Development Board.

General Pick

Robert M. Reindollar (M. '32), age 62, highway expert and former president of the American Road Builders Association, died at his home in Baltimore, Md., on November 17. As president of ARBA in 1953 and 1954, Mr. Reindollar was the first to advocate a multi-billion dollar national roadbuilding program. He began his highway career with the State Roads Commission of Maryland in 1910, working up to the chairmanship of the commission (1945 to 1951). During this period the Maryland road-building program increased from $7 million to $50 million annually. Mr. Reindollar was also instrumental in the building of the Chesapeake Bay Bridge. Since 1951 he had engaged in private practice in Baltimore as consulting engineer on highway engineering, administration, and traffic problems.

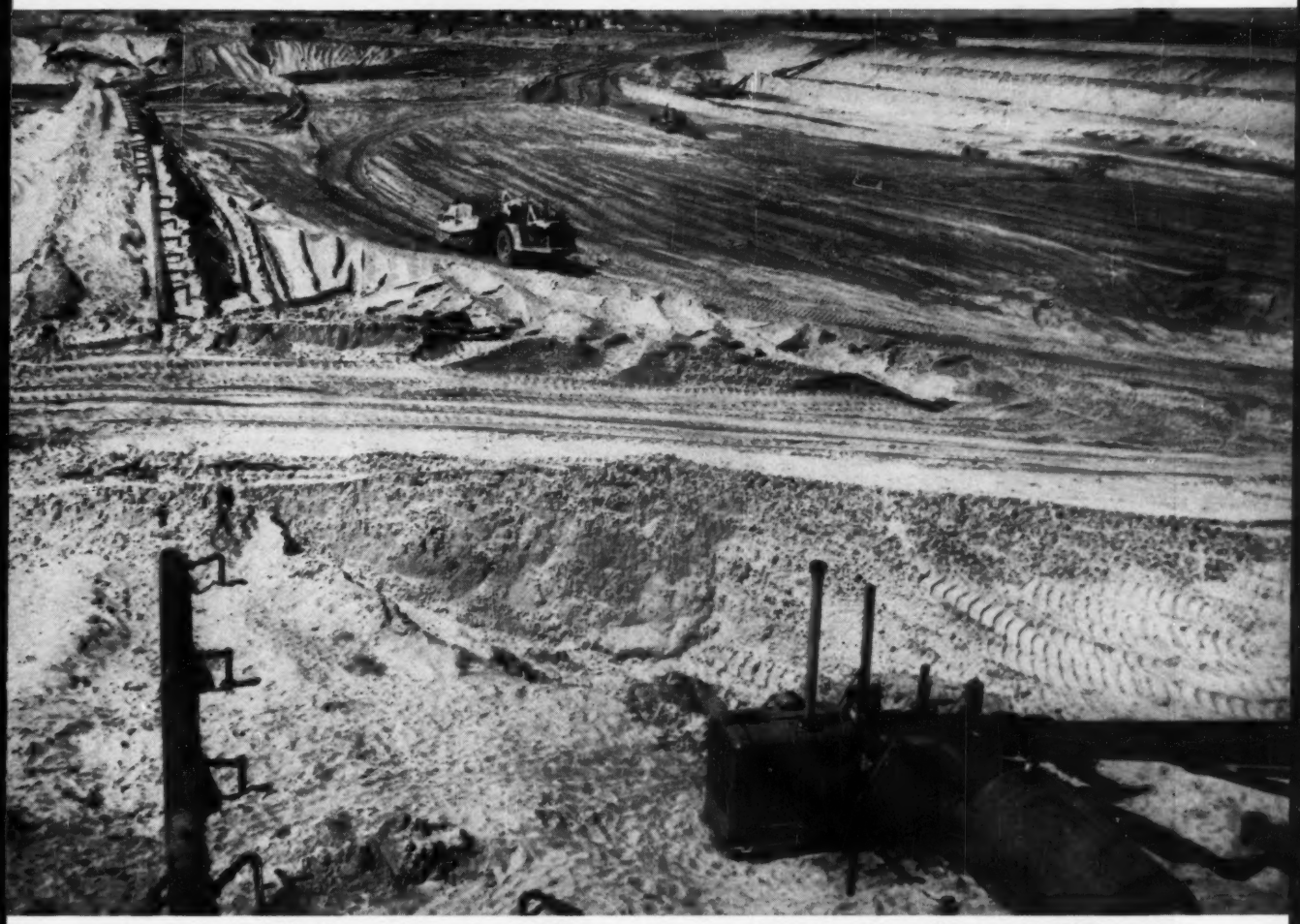
Melvin O. Sylliaasen (M. '31), age 66, consulting engineer of Seattle, Wash., died at his home there recently. A graduate of the University of Washington, class of 1913, Mr. Sylliaasen maintained a consulting private practice in Seattle for many years. During part of this time he also served as city engineer of Seattle in charge of all the city's engineering work and was structural engineer for the Austin Co. of Seattle on the design of large industrial buildings. He designed the Seattle Sewage Treatment Plant, the Ballard Bridge and many large buildings in the Seattle area. Mr. Sylliaasen was an expert witness on many court cases involving ground formations, contractural disputes, public utility and bridge valuations.

Prosper E. Thian (M. '06), age 94, retired consulting engineer with the Northwestern Improvement Co., of the Northern Pacific Railway Co., St. Paul, Minn., died recently at his home in St. Paul. A graduate of Georgetown University, class of 1881, Mr. Thian spent his entire career in the railroad field, and had been chief engineer for railroads in Canada. From 1908 until his retirement in 1940 he was with the Northern Pacific, which he served as construction engineer and valuation engineer. From 1928 on he was consultant to the Northwestern Improvement Co.

Horace Clem Wilson (A.M. '50), age 42, field engineer with the U. S. Pipe & Foundry Co., Bessemer, Ala., died at his home in Birmingham recently. Mr. Wilson graduated from the University of Alabama in 1940 with a degree in civil engineering. During college and after graduation he worked for the Alabama Highway Department in the Bridge Division. He served in the Navy Civil Engineer Corps as an ensign during the war. Mr. Wilson returned to the Alabama Highway Department as associate engineer for a short time prior to joining U. S. Pipe and Foundry in 1946.

Horace Wilson

MORETRENCH WELLPOINTS Dewater 22 Acre Site To A Depth of 27 Feet . . . Contractor Removes 1,000,000 Cubic Yards of Earth in 60 Days!



Borrow Pit "C", Winona, Minn. — Pumping Contractor: American Dewatering Corp., Chicago—New York

Johnson Construction Co., Grove City, Minn., estimates that by using wellpoints to predrain this huge borrow pit and by being able to excavate with rubber-tired equipment, they

"Cut in half, *at least*, the time required to remove the same amount of material using other methods."

Material removed is being used as fill in the construction of Highway 61 between Winona and Homer, Minnesota.

When pumping stops and ground water returns to the site, this pit will become one of Minnesota's famous lakes.

WANT TO MAKE THE DIRT FLY ON YOUR WET JOB?

DIG IT "*IN THE DRY*"!

For full information on pumping any type of project — at a saving — call our nearest office. Sales, rentals, contracts.

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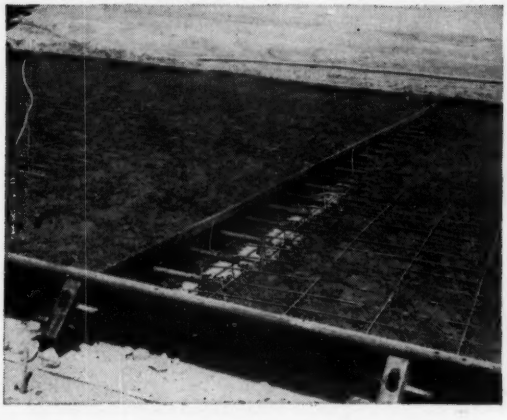
OHIO TURNPIKE



with AMERICAN WELDED WIRE FABRIC

EASY TO INSTALL. American Welded Wire Fabric comes in prefabricated sheets that can be placed quickly with minimum crews. It stays in place during pouring.

LOW COST. American Welded Wire Fabric has high-strength steel wire, electrically welded together for positive anchorage. The concrete slab is effectively reinforced with less steel than other types of reinforcement; so you have less steel to buy and less to handle. American Welded Wire Fabric keeps down maintenance costs, too, because it prevents destructive cracking, keeps roads smooth and safe.

VERSATILE. American Welded Wire Fabric comes in wide sheets for continuously reinforced concrete pavements in wire sizes up to and including ½" in diameter, at 2", 3", 4", and 6" on centers. The use of American Welded Wire Fabric increases the strength of the concrete slab by 30% over that of non-reinforced concrete.

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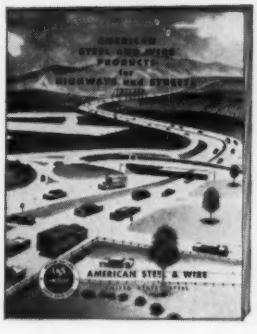
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

Every type of reinforced concrete construction needs

USS American Welded Wire Fabric

UNITED STATES STEEL USS

FREE CATALOG

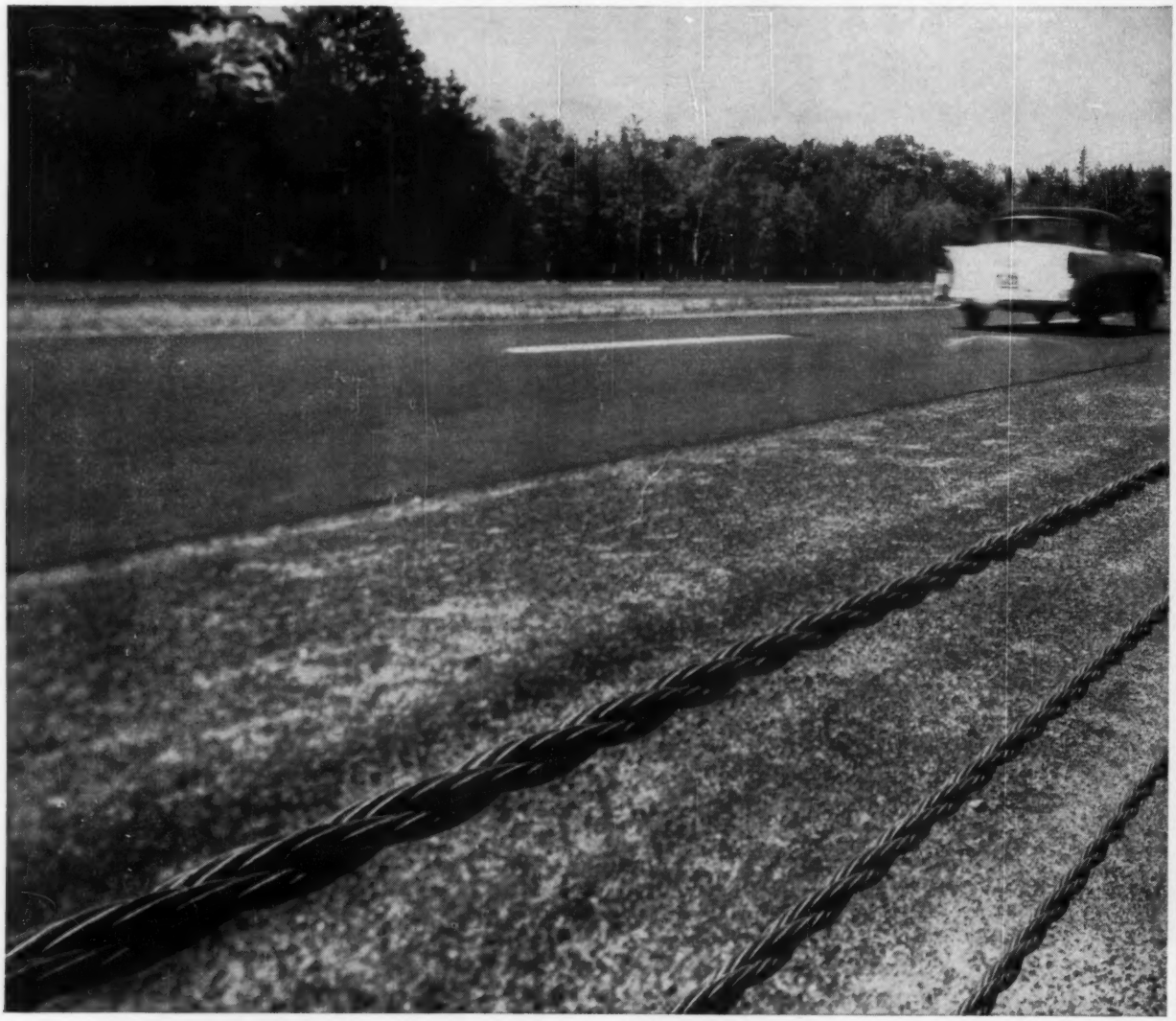


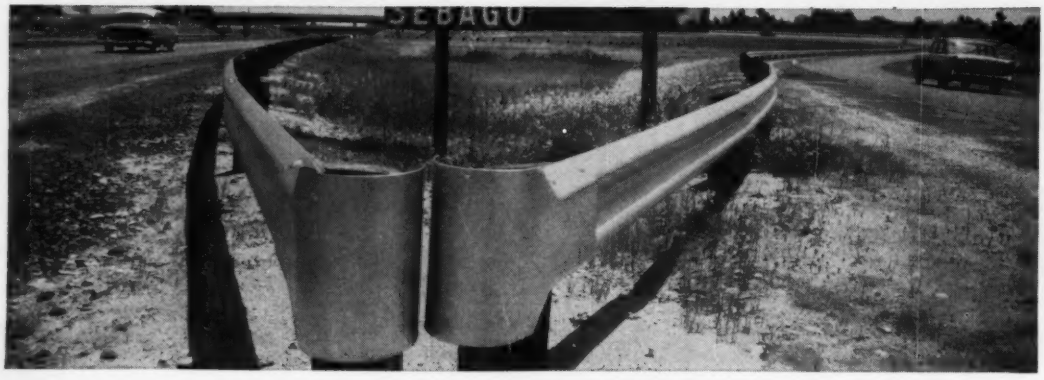
American Products for Highways and Streets

Here's a brand-new catalog describing the entire American line of products for highway and street construction. Includes application photographs and helpful information about each of these products. Send for your copy of this informative catalog today. Use the check box coupon at the end of this 8-page unit. It's free!

On New Maine Turnpike

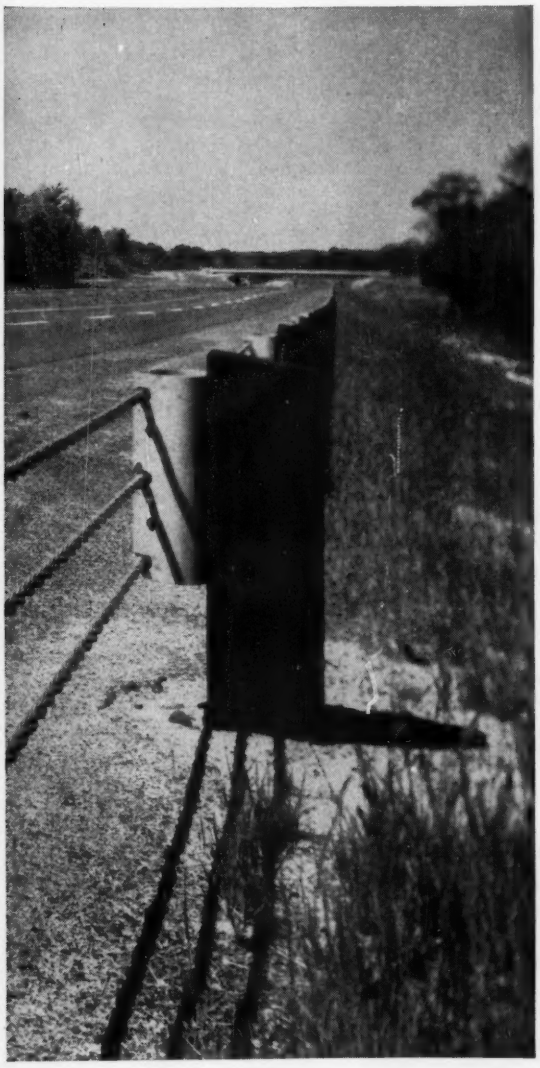
Two types of COMBINE SAFETY WITH





American Highway Guard

GOOD APPEARANCE



▲ American Multisafty Cable Highway Guard, like this used on the new Maine Turnpike, provides two-fold protection. First, it restrains cars from piummeting off the berm. Second, the combination of resilient steel cable and resilient spring-steel offset brackets cushions the shock of collision and helps minimize damage to the vehicle, serious injury to the passengers.

◀ American Beam-Type Highway Guard is also used on parts of the Maine Turnpike. It provides a strong, attractive, durable guard.

THE MEN who designed the Maine Turnpike needed two types of highway guard. Along some sections they wanted to use cable guard; at other sections, they wanted beam-type guard. They obtained *both* types from American Steel & Wire. American Multisafty Highway Cable Guard and American Beam-type Highway Guard assure an economical installation that will stay attractive *and* protective with minimum maintenance. With these two guards they combined essential safety with desirable good looks.

American Multisafty Cable Guard comes in two basic types: 3-cable guard, which gives adequate protection at highway speeds up to about 50 miles per hour; and 4-cable highway guard, which protects up to about 75 miles per hour. A Super Guard consists of six or eight cables for special situations, where an extraordinary margin of safety is desired. In any installation, cables can be added or replaced quickly and easily if changing highway conditions demand additional protection.

Remember the quality and the reputation of American Steel & Wire when you need construction materials of any type of highway guard, wire fabric, road joints, or wire or strand for prestressed concrete. Send the coupon for complete information about any of these products.

AMERICAN STEEL & WIRE DIVISION

United States Steel, General Offices: Cleveland, Ohio

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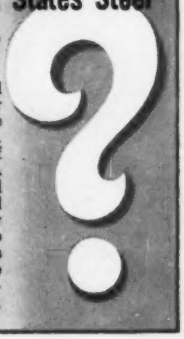
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS Multisafty Highway Guard

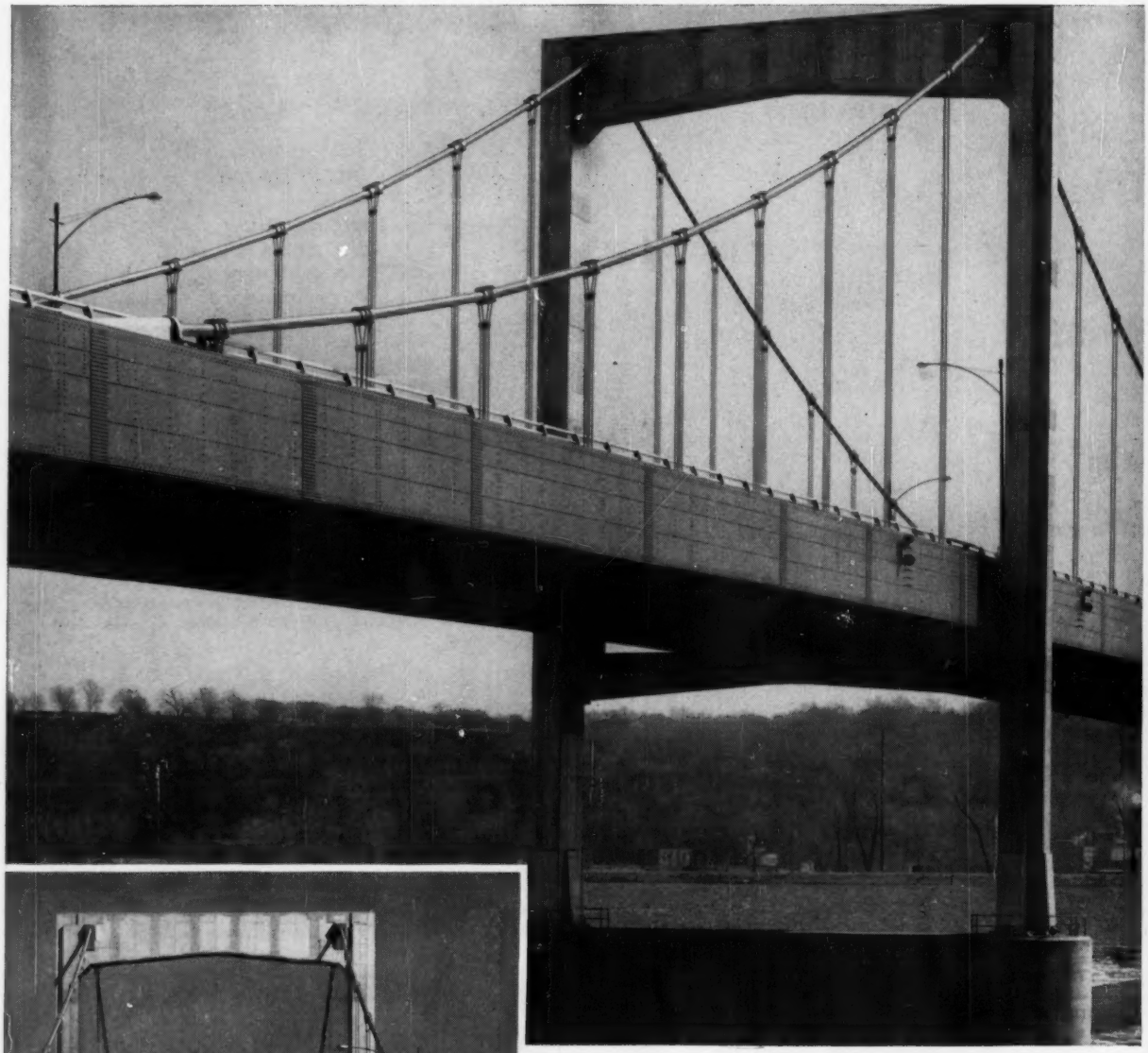
USS **UNITED STATES STEEL**

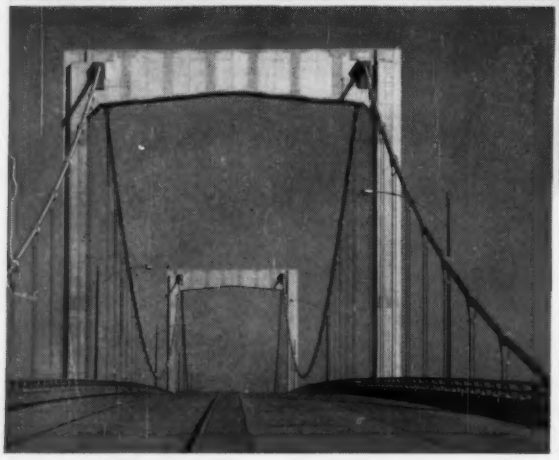
How many products does United States Steel manufacture for road builders?

Have any idea? Know what they are and how they can strengthen and protect your roads? The ads in this 8-page unit describe some of them, but there are many more. You can learn all about the entire line of USS Road Building Products at the ARBA Road Show. Be sure to visit the United States Steel exhibit. You'll see an animated display showing how and where these quality products are put to work in the step-by-step construction of a model highway. Don't miss it! The United States Steel Exhibit at the ARBA Road Show, International Amphitheater in Chicago, Jan. 28 through Feb. 2.



Longest **self-anchored** suspension built with American Tiger Brand





The main cables and suspender cables were engineered and fabricated by American Steel & Wire Division. The main cables are built up of 37 strands each for a total of approximately 94,350 feet of Tiger Brand Galvanized Bridge Strand.

bridge in the United States

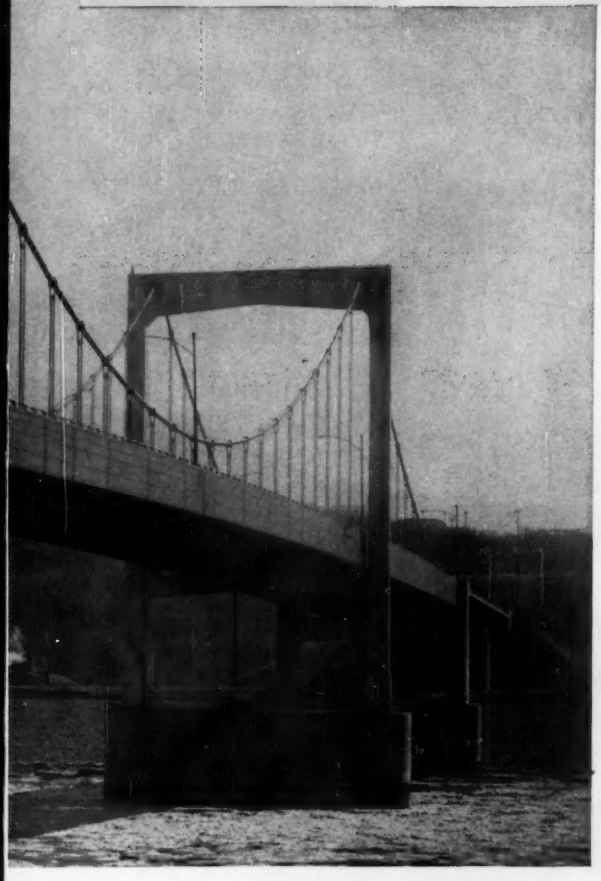
Pre-stressed Bridge Strand

The Paseo Bridge at Kansas City

This 1,232-foot bridge spans the Missouri River and is the longest self-anchored suspension bridge in the United States. The total length of the bridge, including two deck plate girder spans is 1,825 feet. Vertical clearance above high water at center of main span is 55 feet.

Engineers: Howard, Needles, Tammen & Bergendoff, Kansas City, Mo.

Contractor, Fabricator and Erector: American Bridge Division, United States Steel Corporation.



THE PASEO BRIDGE over the Missouri River at Kansas City, Missouri, is unique by comparison with other suspension bridges because it is self-anchored. That is, the stiffening girders themselves are designed and utilized to resist the tension of the main cables, instead of having huge anchorages at each end to resist this force.

This bridge has a 616-foot main span and two 308-foot side spans. Main cables are 12 inches in diameter and are built up of 37 strands—31 strands $1\frac{13}{16}$-inch diameter plus 6 strands $1\frac{1}{4}$-inch diameter. The cables are approximately 1,275 feet long and have a total combined strength of 27,500,000 lbs. To complete the main cables, galvanized soft steel wire is spirally wrapped around the combined strands to protect the cable and provide a smooth surface for painting.

Before shipping, the strands were pre-stressed to one half of their designed breaking strength for several hours. This is not only a thorough test of the quality of the material, but also produces a cable strand that will not stretch over the years due to use.

The stiffening girders carrying two 26-foot roadways are suspended from the main cables by 90 $1\frac{1}{2}$-inch diameter galvanized suspender ropes each having a breaking strength of 104 tons. They were also pre-stressed and fabricated to exact dimensions to fit their places in the structure without further work or adjustment.

American Steel and Wire Division is eminently fitted to handle important jobs like this. It has the engineering experience and complete manufacturing facilities to produce the finest bridge strand you can buy. Call or write for further information.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS AMERICAN TIGER BRAND WIRE ROPE

Excellay Preformed

UNITED STATES STEEL

If you're using prestressed concrete...

THIS NEW BOOKLET ANSWER QUESTIONS LIKE

USS AMERICAN *Super-Tens* WIRE & HIGH

HELPS THESE

SEND THIS COUPON FOR A FREE COPY. This new 16-page booklet describes the complete line of high strength wire, high strength stress-relieved strand, and end fittings manufactured by American Steel & Wire. It contains stress-strain curves, typical tensioning loads and breaking strengths for American Super-Tens Wire and American High Strength Strand—quality products that are especially made for use in prestressed concrete. Send for your copy.

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United States Steel, General Offices: Cleveland, Ohio
Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
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American Steel & Wire
Rockefeller Building
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Please send your descriptive booklets and information on the following:

- ☐ American Super-Tens Wire and American High Strength Strand
- ☐ American Products for Highways and Streets Catalog
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STRENGTH STRAND

UNITED STATES STEEL

FOR PILE DRIVING

Call C. L. GUILD CONSTRUCTION CO., INC.

No Matter What the Project... No Matter Where Your Job...

This Guild rig is shown driving Cobi Piles on a $8 million grade separation project in Winchester, Mass.

SPECIALISTS IN THE USE OF COBI PILES

C. L. GUILD
CONSTRUCTION CO., INC.

94 Water Street, East Providence, R. I.
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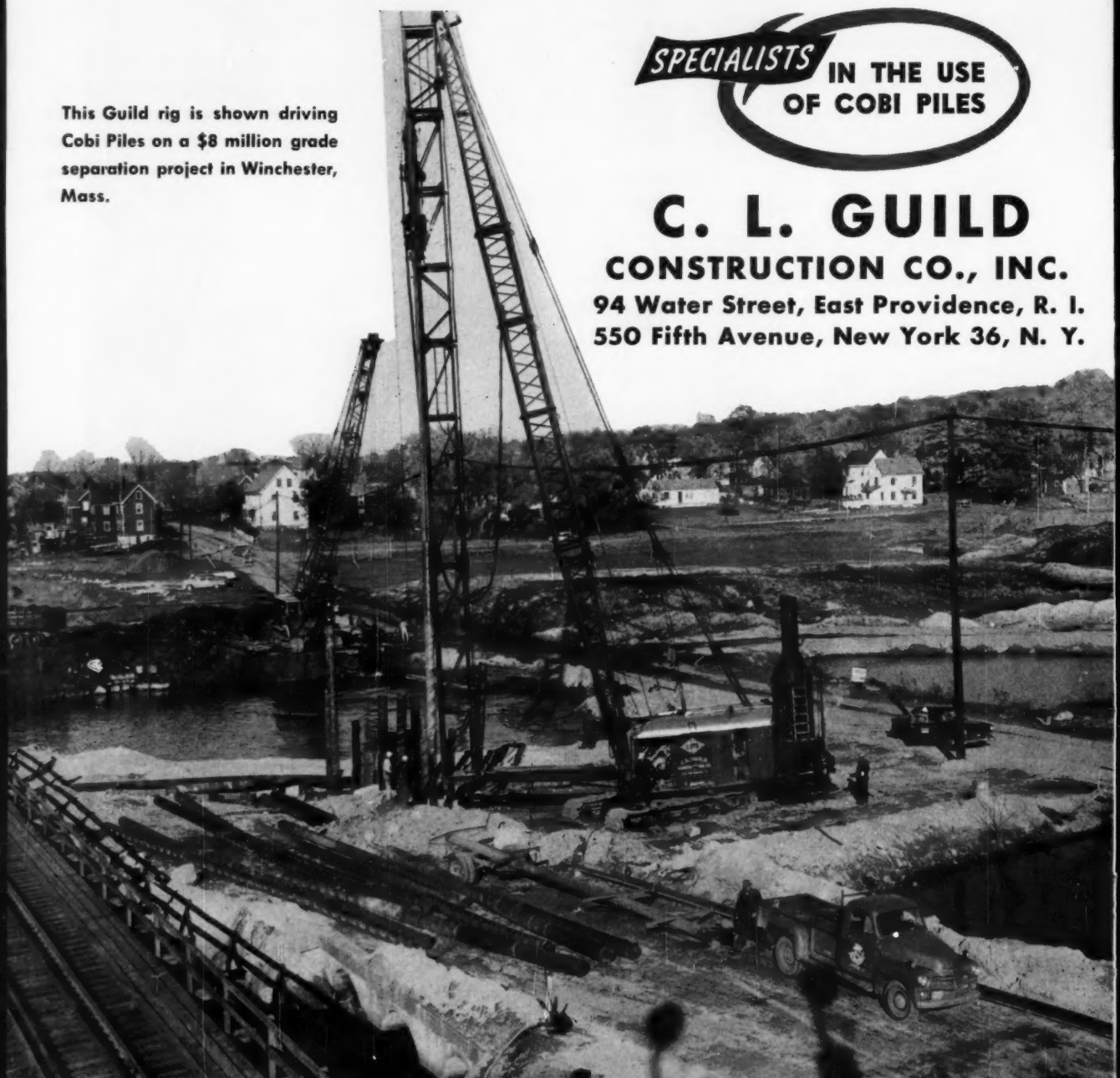

Pike's Peak overlooks east side of Ute Pass in Colorado.
Motorists travel highway safely, securely on asphalt.

Tourist attraction in Colorado—

Good Roads with STANDARD Asphalt

Motorists want good roads. They like to drive on asphalt. Contractors building roads in Mid-America benefit by specifying STANDARD Asphalt. Here's why:

1 Assured source of supply. Standard Oil has a demonstrated record of deliveries on contract. Contractors know that when they order from Standard, they have an assured source of supply.

2 Convenient source of supply. Tank car and tank truck deliveries are made from five conveniently located Standard Oil refineries.

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3 Complete line. Standard Oil makes a full line of paving asphalts. They meet most rigid requirements.

4 Experienced asphalt sales specialists. Standard Oil men who sell asphalt know road construction, know what a contractor's needs and problems are. They know how and what to do to give a builder service on asphalt.

Get more information about the advantages of ordering STANDARD Asphalt. Call any of the 23 Standard Oil offices in the 15 Midwest or Rocky Mountain states. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY
(Indiana)

STANDARD

All over Texas the TD-14's get jobs, and *produce!*

Over 225 International have whipped tough for Brown

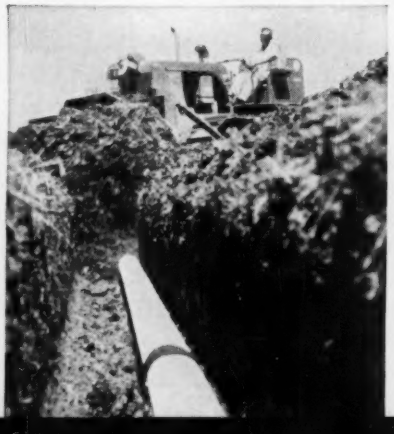
BUILDING FIRE WALLS IN LIBERTY. One of ten TD-14 tractors, recently purchased by Brown and Root, builds roads, flood dikes, and clears land for new well sites. New TD-14 provides genuine "in-seat" starting!

SPREADING AND COMPACTING IN HOUSTON. TD-14 with both ends busy, spreads fill and compacts it at the same time with a sheepsfoot roller. Construction is for preparation of new Juvenile Detention Home site for Harris County.

SPREADING FILL IN HOUSTON. This TD-14 levels land on 360-acre naturalistic park, on south shore of Lake Houston. The new bonus-powered TD-14 has new bridge-strong box-beam track frames—for big-capacity, tough-material dozing!

BACKFILLING TRENCH IN TEXAS CITY. A 74-mile long, 8-inch pipeline from Hull to Texas City undergoes its last operation with another TD-14. Cerametallic engine clutch facings reduce operator effort and prolong clutch life in fast "shuttle-dozing" like this!

REPLACING PIPELINE IN HOUSTON. Stationed near home, this TD-14 joins a trench-hoe to move muck for pipeline replacement in railroad yard, at Sheffield Steel Company. In muck, mud, or water, new track roller seals save inspections...exclude grit, retain lubricant.



TD-14's
jobs everywhere
and Root, Inc.
and associate Companies

BROWN AND ROOT RADIO-DISPATCHED TRUCK with International TD-14 gets "go-ahead" from dispatcher. Because of modern methods, Brown and Root TD-14's can be on the job anywhere in East Texas in just a few hours. No special haulage permit needed to transport the easy-to-truck TD-14!

International TD-14's give big contractor "middleweight" mobility and heavy work *power-punch*... to profitably finish jobs fast!

Internationally-famous contractor, Brown and Root, Inc., take the tough jobs wherever they are, from Guam to Guatemala—from Alaska to Calcutta. On work requiring 70-80 dbhp, they have purchased more than 225 International TD-14 crawlers to get unmatched job-to-job mobility and big capacity.

Another big reason for this choice, the TD-14 starts seconds-fast in all weather with famous International gasoline-conversion diesel starting. It's on the job fast without profit-gobbling delays!

Another big reason, new built-in operating ease, control tower visibility, hydraulic booster steering, clean geared-for-action deck, adjustable deep-cushioned seat. ALL add job-getting efficiency and cost-cutting capacity!

Other reasons: low operating cost; servicing ease! The heat-defying new Cerametallic engine clutch facings increase life, save adjustments! Famous micrometric fuel pump precision saves fuel, postpones overhauls. New track-roller seals hold greasing to 500-hr. intervals!

Reasons like these are why contractors everyhere are standardizing on bonus-powered International crawlers! Try one on your next job. Your International Construction Equipment Distributor will gladly demonstrate!

BREAKING DOWN RICE LEVEES IN ANAHUAC. Not all of Brown and Root Corporation's TD-14's work on industrial projects. This one tears down rice levees on a special assignment when oil field or other work is slack.

INTERNATIONAL HARVESTER

INTERNATIONAL® Construction Equipment

A COMPLETE POWER PACKAGE INCLUDING: Crawler, Wheel, and Side Boom Tractors . . . Self-Propelled Scrapers and Bottom Dumps . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Trucks . . . Diesel and Carbureted Engines . . . Rider Trucks

11 rock-speeding PAYHAULER® TRUCKS star in seaway's biggest, single show!

8 other International® rigs help move 2,451,000 cu yd of rock and earth in $14½ million lock construction!

Eleven International "95" PAYHAULER trucks...because of their high speed, big pay-capacity and around-the-clock endurance...are playing the starring roles in the St. Lawrence Seaway's biggest, and perhaps toughest, single show!

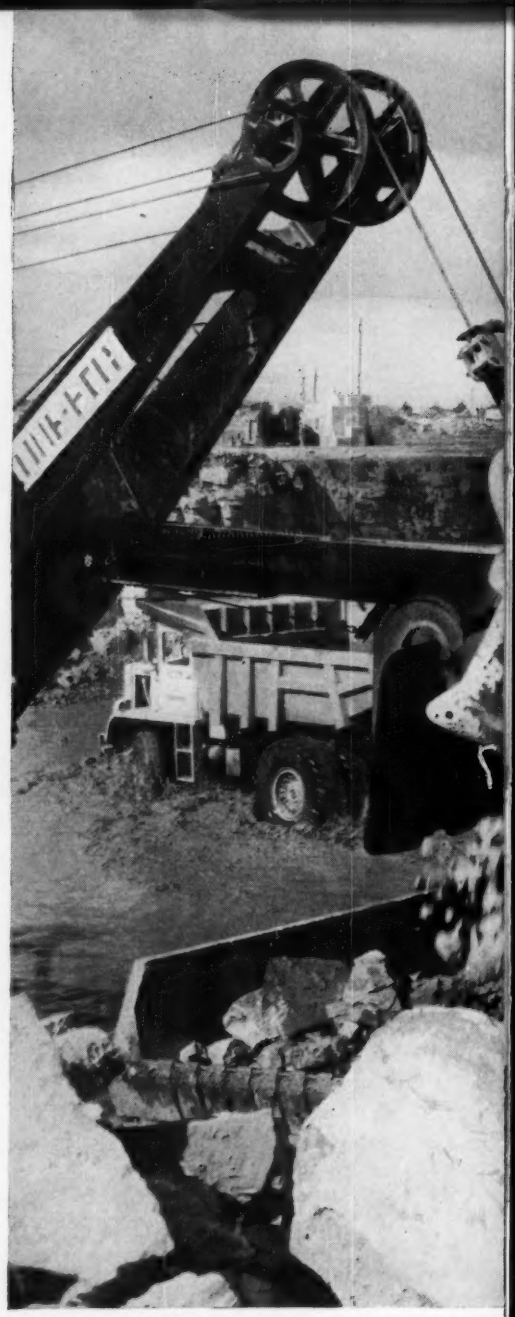
The PAYHAULER units are sparking a demanding monthly production schedule of 120,000 yds of rock and 100,000 yds of common earth. The scene is United Waterways Constructor's $14½ million contract of the upper Beauharnois lock construction and channel excavation near Montreal, Quebec.

International TD-24 crawler tractors, TD-14 Skid Shovels, and a "75" PAYSCRAPER® are also vital producers in the moving of the total required 1,461,000 yds of rock and 990,000 yds of earth. Lock completion is scheduled for December, 1958.

PAYHAULER units have also been moving most of the rock on a lower Beauharnois lock. On a similar shorter-haul rock job in the midwest recently, two identical PAYHAULER units maintained a production average of 2,400 cu yds per day!...And here on the seaway, with average 4,000-foot one-way hauls, PAYHAULER units' high speed, next-to-automatic Torqmatic brake control, and minute-saving, easy-to-heap big capacity are cutting cycle time to a minimum and bringing home maximum loads as well.

The rugged PAYHAULER units on the seaway job are standing up to the toughest test in their spectacular career. They're working around the clock, 5 days per week, hauling mostly rock but also proving themselves in wet, job-fouling mud and on slippery, water-soaked lock floors.

Success on the seaway and on other tough jobs the country over is proving International PAYHAULER units to be what construction men themselves asked for...a big-capacity, high-speed hauler with low downtime and operating costs. See for yourself. Try an International PAYHAULER unit on your job.



TON-SIZED ROCKS go up...then down into fill in 12 seconds. Two-stage hydraulic hoist provides full-time power control. Hydraulic snubbing assures over-center dumping, gentles body return.

38 MPH SPEEDS keep three or four PAYHAULER units on haul road at all times. Hand-operated Torqmatic brake gives accurate control for safe, high-speed travel on congested haul roads. TD-24 tractor spreads rock for fill at railroad diversion.

MAXIMUM SHOVEL OUTPUT on upper Beauharnois lock construction is maintained by fast, easy-loading International "95" PAYHAULER units. High tensile steel sides, triple section bottom, super-duty "spring cushions" plus strongest frame in "95's" class stand rock-shock!

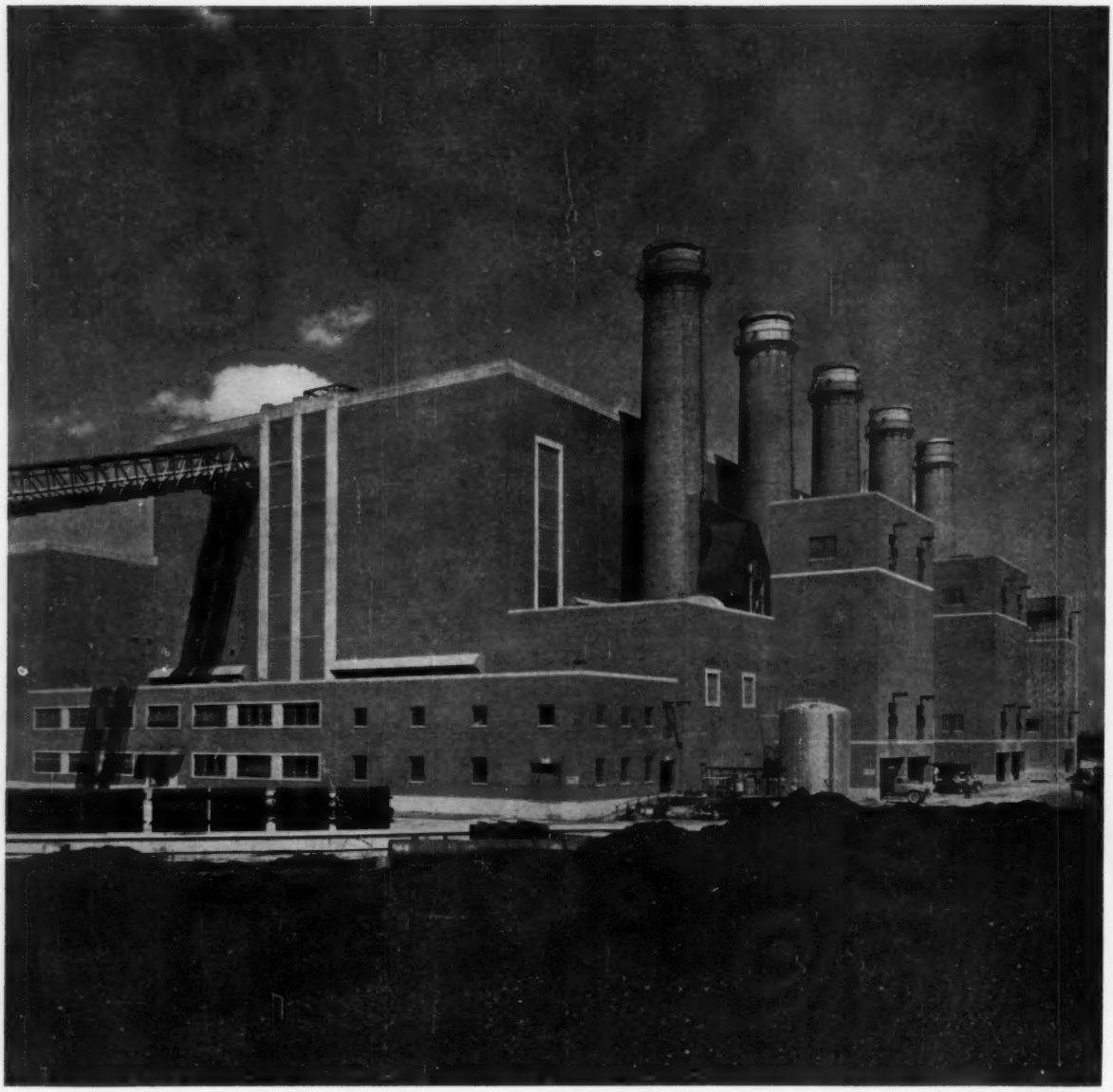
Construction details St. Lawrence Seaway Project #33

Project length	5,000 feet	500,000 yd rock	aggregate plant
Width of lock excavation	60 to 150 feet	270,000 yd rock	structure fill
Depth of lock excavation	54 feet	70,000 yd rock	railroad diversion
Approximate use and disposal of excavated material:		60,000 yd rock	yard areas, construction roads
40,000 yd brown clay	dyke construction	15,000 yd rock	rip-rap and dykes
400,000 yd earth	random fill	15,000 yd rock	service roads

INTERNATIONAL®
Construction Equipment

INTERNATIONAL HARVESTER

A COMPLETE POWER PACKAGE INCLUDING: Crawler, Wheel, and Side-Boom Tractors . . . Self-Propelled Scrapers and Bottom-Dumps . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Trucks . . . Diesel and Carbureted Engines . . . Motor Trucks



The stacks tell the story

The far stack, newly completed, is the tip-off. It foretells installation of a fifth generating unit at Potomac Electric Power Company's newest and largest plant.

This steam-electric generating station, on the Potomac River just across from Washington, has grown enormously since completion of Unit One in 1949. Another 80,000-kw unit was added in 1950, and 90,000-kw units in 1954 and 1956. When Potomac Electric puts Unit Five into operation, probably in the spring of 1957, the rated capacity of the plant will total 430,000 kw; its effective capability, 493,000 kw.

The steelwork required to support and house these five huge units was fabricated and erected by Bethlehem. In total, 8,400 tons of structural steel and over 300 tons of substation structures were supplied to help fill the growing demand for electric power in and around the nation's capital.

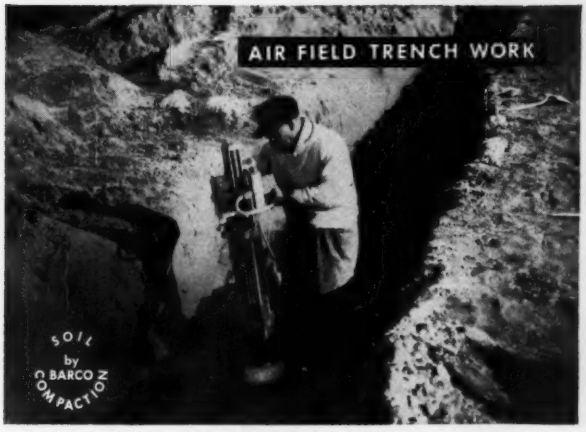
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

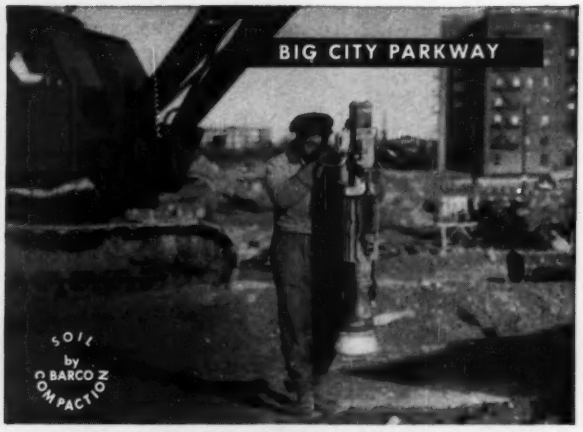
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

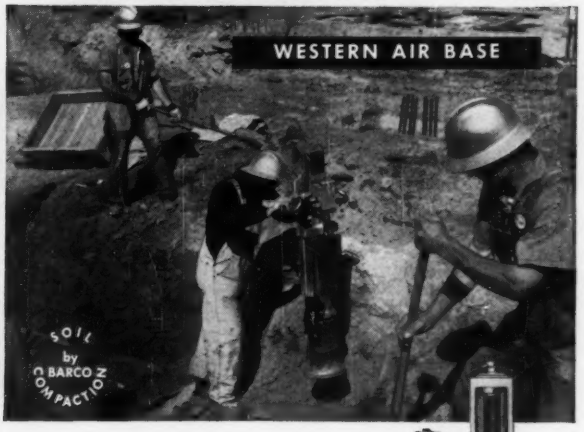
BETHLEHEM STEEL

BETHLEHEM STEEL

GASOLINE **BARCO** RAMMER







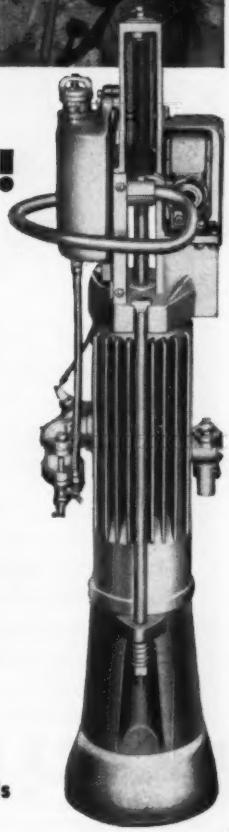
The Key to Better Construction!

NO RECENT TREND in construction has had a more phenomenal growth than the specification of HIGH DEGREE SOIL COMPACTION for all kinds of projects—Atomic Energy, Hydroelectric Power and Flood Control Dams, Highways, Toll Roads and Freeways, Airports, Bridges, Buildings, and Housing Developments! The increase in the use of Barco Rammers on these jobs has been equally great.

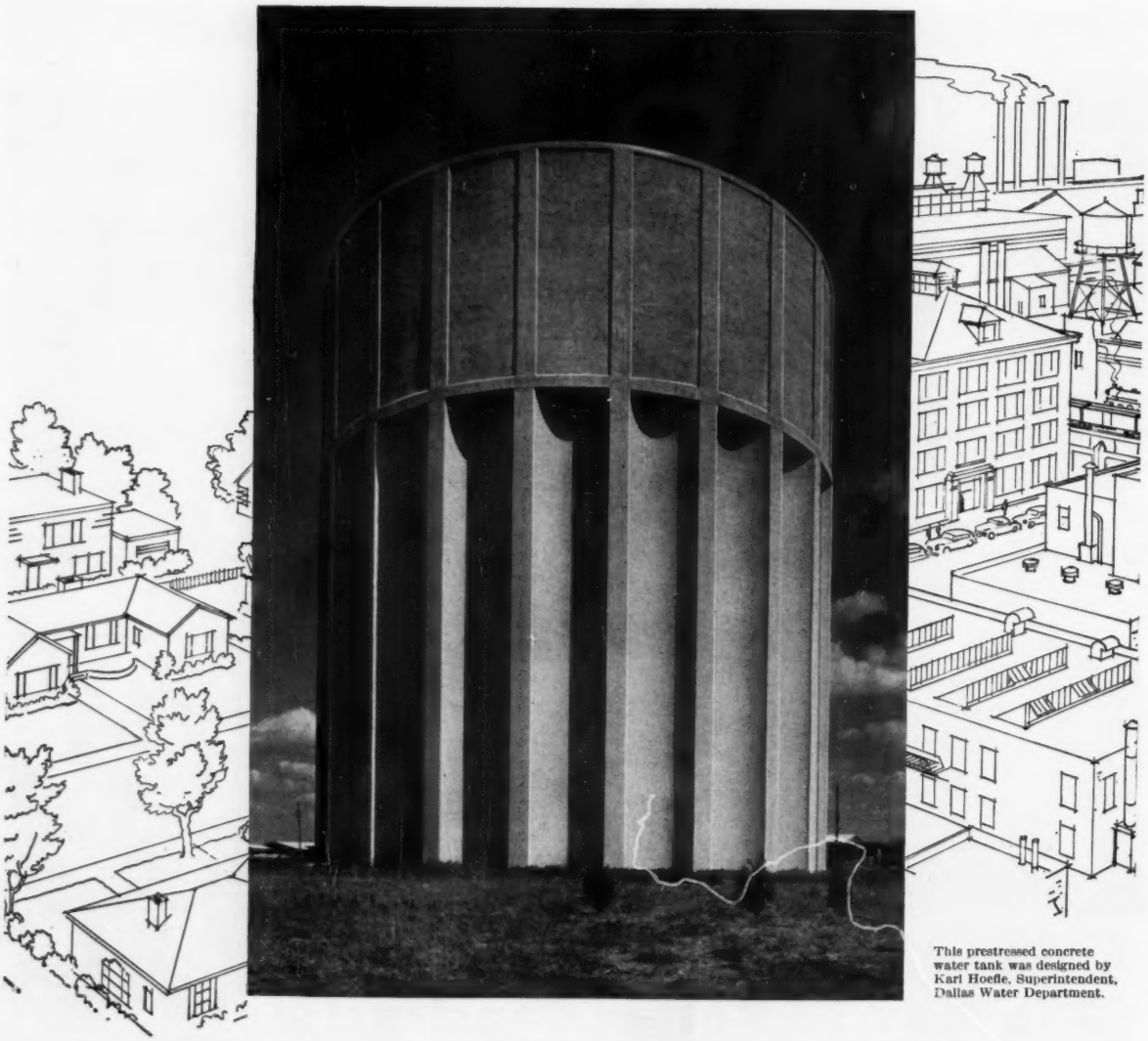
Easily meets rigid specifications—
In test after test, Barco Rammers have demonstrated their ability to deliver 95% to 97.5% compaction (modified Proctor Method)—EASILY! EFFICIENTLY! ECONOMICALLY! The Barco Rammer is especially useful for compacting fill in restricted areas—close to walls, culverts, abutments, around footings, and in trenches. ONLY the Barco Rammer can produce specified high degree compaction on lifts up to 20 inches.

Gets jobs finished on time—
One of the biggest advantages offered by Barco Rammers is ability to handle work in minimum time. On area tamping, one man can average 20 to 30 cubic yards of fill per hour. On trench backfill, using lifts up to 24″, the rate for 18″ trench is 360 to 600 feet per hour.

Barco performance pays dividends! We will be glad to arrange a demonstration for you—see our nearest dealer or write.



BARCO MANUFACTURING CO. BARCO **561-B Hough Street, Barrington, Illinois**



This prestressed concrete water tank was designed by Karl Hoefle, Superintendent, Dallas Water Department.

FOR WATER TANKS OF DISTINCTION

CHOOSE *CONCRETE*

A well-designed concrete water tank such as this 2,000,000 gal. prestressed concrete water tank not only has long-lasting utility, but also unusual beauty. It is an outstanding landmark in the Casa View Heights section of Dallas, Texas.

Any city, large or small, can obtain lasting benefits by building such a reinforced concrete water tank. Its sturdy construction gives it the durability to withstand the weathering action of any climate. Its enduring beauty makes it a structure of which the entire community always can be proud.

A reinforced concrete water tank can be erected in practically any location without marring the skyline or depreciating the appearance or value of the property in the area.

Best of all, reinforced concrete water tanks are more economical than other types. They require little or no maintenance. They retain their distinctive appearance over their long life. And they render ***low-annual-cost*** service—the true measure of construction value. Such service pleases taxpayers, engineers and municipal officials alike.

PORTLAND CEMENT ASSOCIATION

33 WEST GRAND AVENUE, CHICAGO 10, ILLINOIS

A national organization to improve and extend the uses of portland cement and concrete through scientific research and engineering field work

Time and Temper Saver for St. Louis Drivers

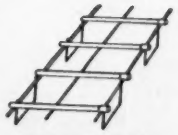
STRENGTHENED and STABILIZED with . . .

LACLEDE HIGHWAY STEELS

ST. LOUIS' new Third Street Interregional Highway represents the first phase of a multi-million-dollar expressway program designed to speed traffic flow and relieve traffic congestion in the St. Louis area.

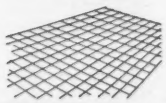
Like so many other highways in the Heart of America, this easy-riding high-speed artery is made stronger, safer and more durable with Laclede reinforcing steels.

MISSOURI STATE HIGHWAY DEPARTMENT
GENERAL CONTRACTOR:
Fruin-Colnon Contracting Company



WELDED DOWEL SPACERS

MULTI-RIB ROUND REINFORCING BARS

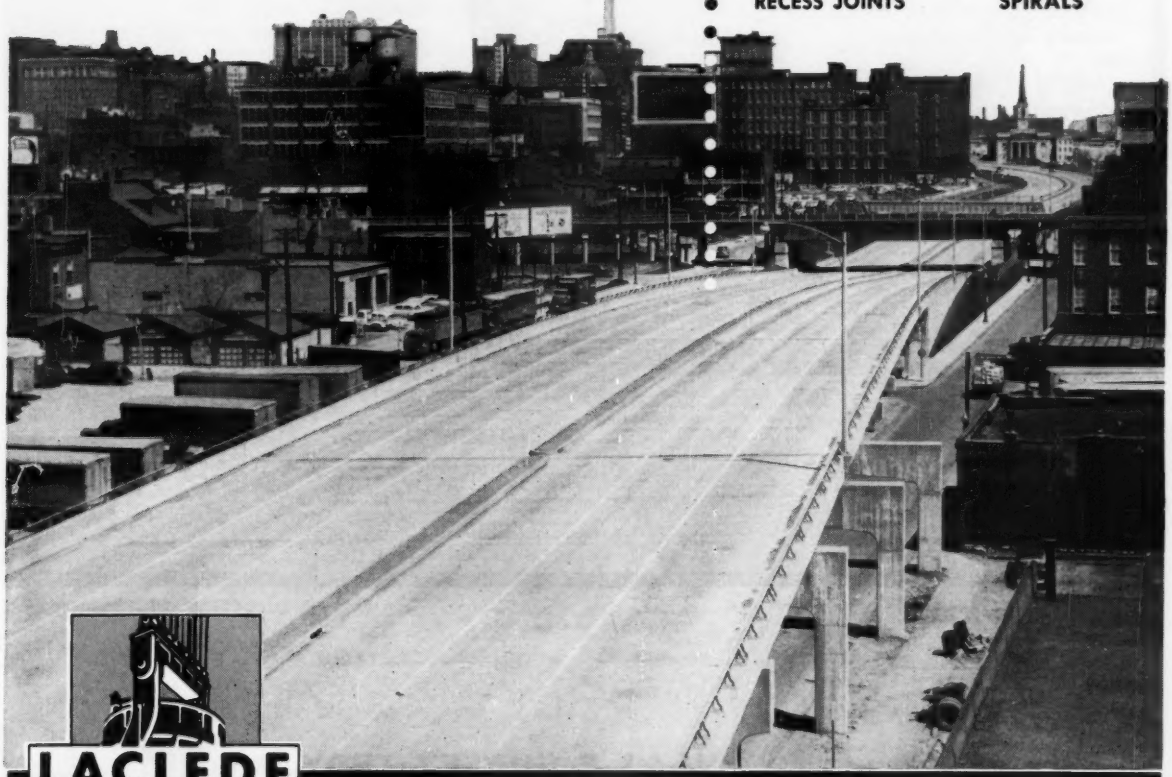


WELDED WIRE FABRIC (in sheets)

CENTER JOINTS

RECESS JOINTS

SPIRALS



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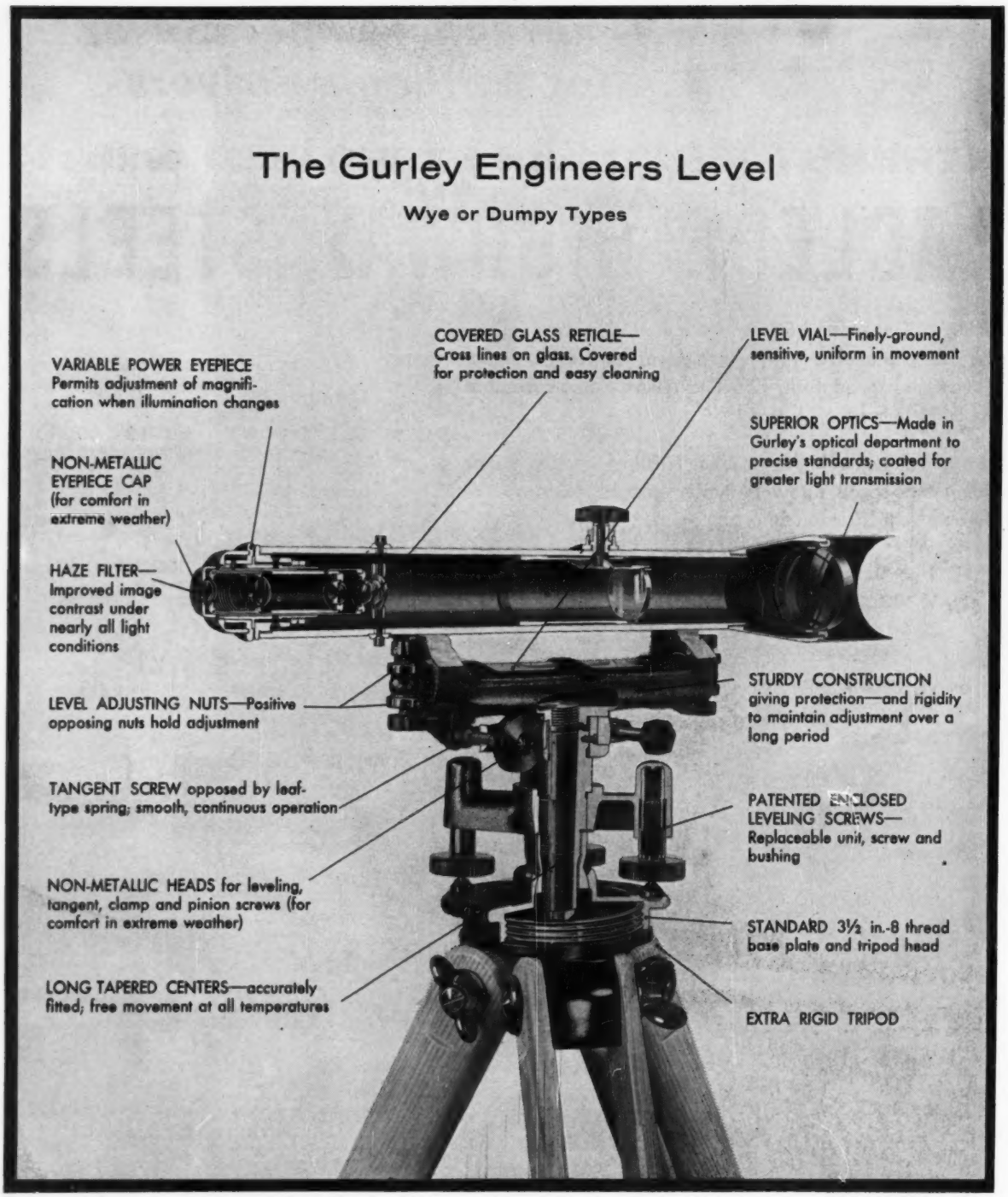
LACLEDE STEEL COMPANY

SAINT LOUIS, MISSOURI ◆ Producers of Steel for Industry and Construction

The Gurley Engineers Level

Wye or Dumpy Types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(for comfort in extreme weather)
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Cross lines on glass. Covered for protection and easy cleaning
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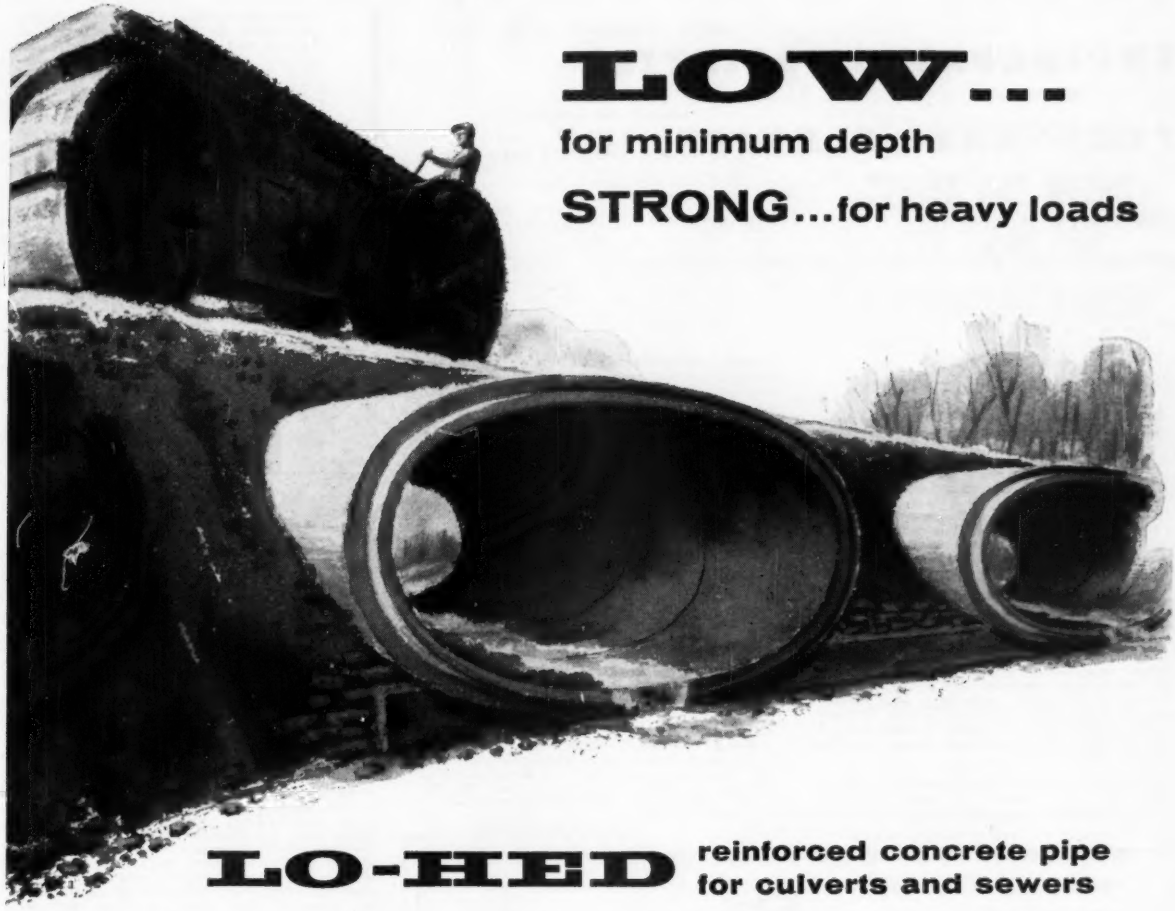
STURDY CONSTRUCTION
giving protection—and rigidity to maintain adjustment over a long period
PATENTED ENCLOSED LEVELING SCREWS—
Replaceable unit, screw and bushing
STANDARD 3½ in.-8 thread base plate and tripod head
EXTRA RIGID TRIPOD

Model 372 Dumpy Level

GURLEY

W. & L. E. GURLEY, TROY, N. Y.



LOW...

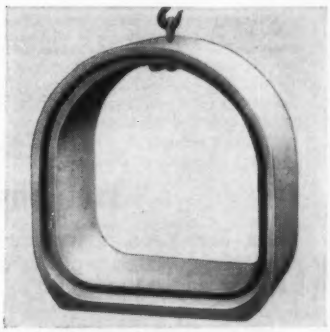
for minimum depth

STRONG...for heavy loads

LO-HED reinforced concrete pipe for culverts and sewers

Elliptical LO-HED Pipe carries a greater flow than its round equivalent in a shallower ditch—has the strength to support tremendous loads. It is easier to lay, to grade and line. LO-HED Pipe features smooth walls and tight joints for maximum hydraulic capacity with less build-up of debris in the invert, even under low-flow conditions. Write for free brochure containing hydraulic characteristics and discharge diagrams on a full range of sizes for nearly all culvert and drainage installations.

Our technical staff will be pleased to assist you with your pipe problems.



FLAT-BASE PIPE

Other uses for under-highway pipe are provided by Flat-Base . . . as an underpass for pedestrians, cattle and conveyances—as utility galleries or industrial tunnels. Write today for illustrated literature.

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Men Available
January 1957

CHIEF ENGINEER OR PROJECT ENGINEER, A.M. ASCE; civil engineering education, 46; 30 years' hydroelectric, dams, airports, highways, industrial, surveys, design and supervision construction. P.E. license. Locations desired: foreign as first choice and domestic second choice. C-176.

CIVIL ENGINEER, M. ASCE; graduated M.S. in 1942; 38; married. Wide and responsible experience in administration, planning and construction of reinforced concrete structures, project reports, etc. Much dealing with different people under managerial position or as a chief engineer. Fluent Spanish. Seeks position with future. Locations desired: South America or some other country. Now in Chile. C-177.

MUNICIPAL ENGINEER, J. M. ASCE; B.C.E.; 26. 5 years' progressively responsible experience, layout, estimating, contract administration, personnel administration, budgeting, plant maintenance, scheduling, road construction; military service completed; supervised preparation of contract drawings and specifications. Location desired: East. C-178.

ASSISTANT ENGINEER, J.M. ASCE; M.S. in C.E.; 28; P.E. license; 5 years' structural bridge engineering experience. Desire career employment demanding broad application of engineering. Locations desired: Northeast, D.C. New York City. C-179.

CIVIL ENGINEER, J.M. ASCE; B.C.E.; 31; married; 2 years' as field engineer in construction of water and sewer systems and plants. 2½ years' responsible experience in direction of public works and municipal engineering. Interested in administrative, supervisory, or practical engineering position. C-180.

CHIEF STRUCTURAL ENGINEER, M. ASCE; degree in C.E.; 58; 30 years' subways, buildings, waterfront, power plants, foundations, chemical plants. Location desired: East. C-181.

Positions Available

DESIGN AND CONSTRUCTION ENGINEER with at least 5 years' experience in prestressed concrete construction. Salary, $7,000-$9,000 a year. Location, upstate New York. W-4234.

ASSISTANT OR ASSOCIATE PROFESSORS, under 40, Ph.D. preferred, M.S. acceptable, for civil engineering department. Part time research and part time graduate and/or undergraduate teaching. Must have special training or experience in highway engineering or in structures. Salaries, on a 12-month basis, $6,000-$7,500 a year. Location, South. W-4237.

CONSTRUCTION SUPERVISOR, B.S. or M.S. in mechanical, electrical or chemical engineering, experience not essential but will consider applicant up to 10 years out of college. Will be responsible for the coordination of the design and construction of new factories and process units. Will direct the efforts of outside engineers and maintain liaison with design engineers. Salary open. Location, Ohio. W-4275(*b*).

CIVIL ENGINEER, graduate, or any equivalent combination of training and experience; 21-55; United States citizen; with experience in highway, street or other public works projects, for investigation, development, design, construction and maintenance of civil engineering projects in a municipality. Location, Florida. W-4284.

ENGINEERS. (a) Manager of Engineering, 40-50, graduate civil or mechanical engineer, with 10 to 15 years' experience in engineering to include experience in design, project engineering and at least several years' as manager or assistant manager of a large engineering department or division, or chief engineer of an operating company. Some experience in steel plant engineering is desired. Duties will include furnishing engineering services to clients, including consulting services, engineering studies, development of basic scope and criteria, estimates of costs, etc. Salary open. (*b*) Manager of Steel Plant Project Division, 35-50, graduate experience primarily in iron and steel plant engineering including experience in design, layout and project engineering relative to the essential elements of an integrated steel plant, including raw materials handling and processing. Must have a proven record in responsible charge of engineering work in connection with iron and steel plants. Will be responsible to manager of engineering for furnishing consulting services, engineering studies, development of basic scope and criteria. etc. Salary open. Location, West Coast. W-4288.

STRUCTURAL ENGINEER to head up structural design department of medium size architect's office, with a practice consisting primarily of industrial, commercial and institutional work and schools. Excellent, permanent opportunity. Apply by letter giving full information. Location, Gulf South area. W-4306.

ASSISTANT MANAGER FOR FIELD ACTIVITIES, Industrial Construction Division, 40-50, degree in engineering, with 15 years' experience primarily in the field of heavy industrial construction including experience on large construction projects as construction superintendent, resident manager and supervisor of field construction from the home office. Will be responsible to manager of Industrial Construction for supervision of field construction to assure that construction is completed in accordance with approved plans and specifications, schedules and budgetary requirements. Salary open. Extensive travel. Location, West Coast. W-4289.

INSTRUCTORS in Civil Engineering, to teach service courses in analytical mechanics, strength of materials, hydraulics. Preferably M.S. degree. Salaries and ranks will depend upon education and experience; nine months teaching. Location, West. W-4301(*a*).

DESIGN ENGINEERS, structural, 25-45, for the design of various types of steel structures including buildings, grandstands, swimming pools, bridges, tanks, pressure vessels, wind tunnels, etc. Will work under general supervision. Should have minimum of 5 years' design experience. Salary, $6,000-$10,000 a year. Location, Pittsburgh, Pa. W-4308.

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Paul Keating, Murray Hill 7-7100, New York City
Joe Braddick, Fairfax 3-2401, Houston, Texas
Bill Milligan, Tucker 1549, Los Angeles, Calif.
Don Palmer, Douglas 2-4032, San Francisco, Calif.

ASSISTANT EDITOR, graduate civil, preferably 2 years out of college, with some experience in writing for technical engineering magazine. Salary, $6,000-$7,000 a year. Location, New York, N. Y. W-4311.

INSTRUCTORS-ASSISTANT PROFESSOR, B.S. or M.S. in civil engineering, to teach a variety of civil engineering subjects. Previous teaching experience not required. Positions available in February, 1957 to September, 1957. Salary and rank dependent upon qualifications. Location, West. W-4327.

ENGINEERS: (*a*) Construction Engineer, with at least 5 years' office engineering experience in chemical process fields. Considerable traveling. Salary, to $9,500 a year. (*b*) Field Engineer, 25-30, engineering graduate with process construction experience. Considerable traveling. Salary, $5000-$6,000 a year. Company pays placement fees. Headquarters, eastern Pennsylvania. W-4328.

ENGINEERS: (*a*) Foundation Engineer, graduate civil, for hydroelectric project. Must have at least 10 years' experience, some of which should have been on concrete dams. Grouting experience desirable. Salary, $10,800-$12,000 a year, plus living allowance. Two-year contract. Single status preferred or just man with wife as no school facilities are available. (*b*) Hydroelectric Engineer with at least 10 or 15 years' experience on hydroelectric projects. Should have minimum of 2 to 3 years in responsible charge of such projects. Design work. Salary, $12,000 a year plus living allowance. Applicant may take wife and family as there are good living and school accommodations. Location, Turkey. F-4336.

CIVIL ENGINEER to work as assistant in sponsored research on soils. Opportunity to do graduate work tuition free. Location, New Jersey. W-4348.

MAINTENANCE ENGINEER, graduate civil, for supervision of construction maintenance and design of school buildings. Must be licensed P.E. and have background of building construction. Will be in charge of inspectors and other personnel. Salary open. Location, New York State. W-4366.

PLANT ENGINEER, over 40, civil engineering graduate, with at least 5 years' industrial plant layout and construction experience. Salary, $8,000-$10,000 a year. Location, southern Connecticut. W-4367.

ENGINEERS, mining or civil, under 30, with some industrial experience for open pit, nonmetallic operations. Salary, to start, $6,000 a year, with fringe benefits. Locations, Southeast and Midwest. W-4395.

FIELD ENGINEERS, civil or mechanical graduates, to erect precipitators on the job site—power plants, steel mills, chemical plants, paper mills and other like installations. Salary, $6,600-$7,800 a year for experienced engineer. Some traveling involved about every six months. In addition to salary, $9.00 per day living expenses. Traveling expenses paid for applicant and family to the job site. Also 12½ per cent company paid pension plan and other company benefits. Location, East. Headquarters, New Jersey. W-4378.

CONSTRUCTION ENGINEER to control construction of overseas fabricating plant supervising contractors, architects and public service installations. Salary open. Headquarters, eastern United States. F-4393(*c*).

OFFICE ASSISTANT, graduate civil, not over 30; must be able to read architectural and structural drawings, make preliminary estimates and keep cost records on precast concrete roof slabs. Salary open. Location, northern New Jersey. W-4394.

DESIGNER, civil, mechanical or electrical, to 55, with limited experience or experienced for industrial plant and central engineering office work related to structural and foundation elements or for plant expansion or construction; primarily structural. For equipment selection, plant layout and design, heavy continuous production equipment for pulp preparation or final production, manufacturer. Electric light and power primarily low voltage secondary, but with some high-tension transformer installation. Salary, up to $8,000 a year. Employer will negotiate relocation and placement cost. Location, San Francisco, East Bay. S-2452.

Applications for Admission to ASCE—Nov. 10-Dec. 1, 1956

Applying for Member

HOWARD ELGIN ARMSTRONG, Montreal, Quebec, Canada.
EDDIE KARL-GASTAV BORJESSON, Port-au-Prince, Haiti.
JAMES EDWARD BURTON, Topeka, Kans.
DANTE JOHN CALDERA, Yonkers, N.Y.
SELDON FRANKLIN CRAMER, Los Angeles, Calif.
JOHN STERLING DAVIS, El Paso, Tex.
JAMES DOUGLAS, Washington, D.C.
LINDLEY RATHBURN DURKEE, Mercer Island, Wash.
ALBERT JAMES FAY., Washington, D.C.
LINWOOD EUGENE FUNCHESS, Houston, Tex.
PATRICK EDWARD GARNER, New York, N.Y.
WILLIAM HUGHES HOAR, Birmingham, Ala.
MICHAEL GERARD KALMAN, Morton, Pa.
NEIL EDGAR KINGSLEY, Arlington, Va.
FRANK STANLEY MACONACHIE, Ottawa, Canada.
THOMAS EDWARD MOORE, Birmingham, Ala.
MANUEL VIRGILIO PATINO, Miami, Fla.
DOUGLAS CAMPBELL SEAMANS, Baytown, Tex.
JOHN ARTHUR STIRTON, San Francisco, Calif.
JULIAN ROBERT TAYLOR, Mesilla Park, N. Mex.
JOHN WARD, JR., River Forest, Ill.
LOUIS WASHER, JR., Richmond, Va.
EDGAR BERYL WILSON, Oklahoma City, Okla.
KUO-HUA YANG, New York, N.Y.

Applying for Associate Member

RAFI AHMAD MUHAMMAD SHEIKH, Berkeley, Calif.
HERRICK KIDDER ALLEN, Tacoma, Wash.
WILLIAM ENNIS BARNEY, Pasadena, Calif.
ROBERT ANTHONY BREWER, Berkeley, Calif.
RUSSELL WEATHERBEE BROWN II, Las Cruces, N. Mex.
FRANK ROYCE BUNNELL, Vancouver, B.C., Canada.
MAX CARDIFF, Cincinnati, Ohio
RICHARD ANTON CHRISTENSEN, Omaha, Nebr.
ROBERT MONROE CLEMNETSON, Camp Hill, Pa.
HARRY FREDERIC COOPER, San Diego, Calif.
GUNNAR EEMAN, Toledo, Ohio.
HORACIO ERLIJMAN, Seattle, Wash.
ARTHUR BEECHER GREENMAN, West Islip, N.Y.
IVAN PAUL HEAD, Sacramento, Calif.
JOSEPH DAVID HIATT, Secane, Pa.
EUGENE YU-CHENG HSI, Baltimore, Md.
WALTER RAYMOND HYLANDER, JR., Memphis, Tenn.
CECIL HALE HULL, Baltimore, Md.
FRANK DAVID HUTCHINSON, III, New York, N.Y.
RAYMOND LEE JOHNSON, Omaha, Nebr.
RICHARD OWEN JOSLYN, Kansas City, Mo.
SAMUEL GODFREY KABAKOV, Sacramento, Calif.
HARBANS SINGH KHALSA, Akyab, Burma.
LOUIS HERMAN KLOTZ, Union, N.J.
CARL HENRY KRAENZLIN, San Francisco, Calif.
ARNIE MILES MALLORY, JR., Vicksburg, Miss.
JAMES LAWRENCE MCINTYRE, Montgomery, Ala.
CLARENCE DEAN MILLER, Chicago, Ill.
JOHN HANKS MUNSON, Freeport, Tex.
GURPUR RAMACHANDRA PAI, Madras, India.
EMANUEL PISETENER, Staten Island, N.Y.
DAVID WILSON POHMER, Baltimore, Md.
CARL WILLIAM PUMP, San Bernardino, Calif.
VICTOR MANUEL RADA ARENCIBIA, Caracas, Venezuela, S.A.
THOMAS DON SHREFFLER, Toledo, Ohio.
RAY EDWARD STREIFF, Milwaukee, Wis.
DESI ERICH WEERTH, Tacoma, Wash.
JOHN DARRELL WILLS, Omaha, Nebr.
ALVIN WILLIAM WRIGHT, Lexington, Ky.

Applying for Junior Member

ORLANDO BALDWIN ANDERSLAND, Ottawa, Ill.
AHMED SAEED ARYNE, Berkeley, Calif.
WILLIAM GEORGE CATLIN, La Mesa, Calif.
ANTONIO ALVES, DE NORONHA FILHO, Boston, Mass.
JOHN RAYMOND GROVER, Pittsburgh, Pa.
HAMID IBRAHIM HAMID, Iowa City, Iowa.
LYLE FRANCIS HIRD, Madison, Wis.
EINAR BENJAMIN HOFF, JR., Cleveland, Ohio.
DAVID ANDREW HUNTER, JR., New Orleans, La.
PAUL BYRON JONES, El Paso, Tex.
CLARENCE NICOLAYSEN, Palisade, N.J.
ROBERT BYRON NUNLEY, Westbrook, Me.
DENO GUS PAPPAS, Fort Belvoir, Va.
RASIKLAL SANKALCHAND PATEL, Detroit, Mich.
ROBERT MICHAEL PERRY, New York, N.Y.
THOMAS WILLIAM RYAN, Omaha, Nebr.
CARLTON LAMAR SWOPE, Clearwater, Fla.
JOHN LOUIS TIEDEMANN, Harrisburg, Pa.
PATRICK OTTO WILSON, Seattle, Wash.

[Applications for Junior Membership from ASCE Student Chapters are not listed.]

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Personnel Department

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Recent Books

(Continued from page 28)

Bundesanstalt für Strassenbau

Wissenschaftliche Berichte No. 2. Beurteilung der Tragfahigkeit schwer-belasteter Strassen durch deu Plattendruckversuch

Detailed description and results of tests evaluating the bearing capacity of heavily traveled roads. Profusely illustrated, this report by Peter Siedek and Reimar Voss covers a procedure similar to the ASTM suggested method for static load tests for use in the design of airport and highway pavements. (Wilhelm Ernst & Sohn, Berlin, Germany. 1956. 136pp., paper. DM 16.)

The Chemistry of Cement and Concrete

This volume by F. M. Lea deals with the chemical and physical properties of cements and concretes and their relation to the practical problems that arise in manufacture and use. Broad in scope, the book covers the influence of composition on properties; hydration; setting and hardening; testing; pozzalanic cement; and aggregates. It also deals with special materials such as oil-well cements, nonshrinking cements, and concrete for radiation shielding. In the chapters devoted to the behavior of concrete in use, the main topics treated are the influence of air-entraining agents and other additives; the resistance of concrete to frost, fire, and chemical attack; and the examination of concrete failures. The present edition has been largely rewritten and includes a new chapter on the atomic structure of cementing compounds. (St. Martin's Press, Inc., 103 Park Avenue, New York 17, N. Y. Second edition, 1956. 637pp., bound. $15.00.)

Composition and Properties of Concrete

This text and reference manual by G. E. Troxell and H. E. Davis provides essential information on materials; proportioning and mixing; placing and curing; and properties. In addition to treating ordinary concrete for buildings and highways fully, it deals briefly with gunite, shotcrete, and other special concretes. Inspection records, inspection reports, and methods for the analysis and presentation of data are also covered, and a separate section is devoted to instructions for laboratory tests. (McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. 1956. 43pp., bound. $7.75.)

Contracts, Specifications and Engineering Relations

The first part of this standard text by D. W. Mead deals with the training and work of the engineer, factors determining professional success, engineering ethics, and the writing of letters and reports. The second part deals, briefly, with the engineer in various legal situations, (as an agent, as an expert witness, etc.), and, in more detail, with construction by direct employment and by contract; advertising and letting contracts; and contract documents. The last part of the book covers the preparation of specifications for materials, processes, machinery, and engineering work. Forms, as well as a complete set of specifications for a construction job, are included. This edition rewritten by Mead and Hunt, Inc., with J. R. Ackerman. (McGraw-Hill Book Company, 330 West 42nd Street, New York 36, N. Y. Third edition, 1956. 427pp., bound. $7.00.)

Disposal of Sewage and Other Water-Borne Wastes

The contents of this book by K. Imhoff, W. J. Müller and D. K. B. Thistlethwayte differs from the original German work by Imhoff upon which it was based, in the greater emphasis placed on practices common in countries of the British Commonwealth and in America. Intended as a practical manual for engineers and public officials, it deals in detail with techniques for the treatment of all ordinary

(Continued on page 130)

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Recent Books

(Continued from page 128)

water-borne wastes, including domestic or municipal sewage and industrial wastes. Brief sections cover basic data, methods of disposal, and disposal and treatment of wastes in unsewered areas. (Butterworths Scientific Publications, London WC2, England. 1956. 347pp., bound. 45s.)

Deutscher Auschuss für Stahlbeton

Heft 106. Fahrbahnplatten von Strassenbrücken.

Heft 121. Gas- und Schaumbeton.

No. 106. Design tables for loads on roadway plates of highway bridges. These tables conform to German Standard DIN 1072 covering "permissible loads on . . . bridges". A brief discussion by H. Rüsch of the theory of plates precedes the tables.

No. 121. Three research papers on gas- and air-entrained (porous) concrete: tests on shear in beams of reinforced, air-entrained concrete; moisture in steam-cured air-entrained concrete; tests on shrinkage and expansion. By H. Rüsch, O. Graf and H. Schäffler. (Wilhem Ernst und Sohn, Berlin, Germany, 1956. Heft 106 Third edition. 82pp., bound. D. M. 2400. Hept 121. 37pp. paper. D. M. 9.00.)

Irrigation Engineering, Volume 2.

Projects, Conduits and Structures

Devoted primarily to large gravity irrigation projects and their storage systems, this volume emphasizes the practical requirements for the planning of projects, design of irrigation features, and the construction of irrigation systems. It covers the study of project lands and water; canals and ditches and their linings; flumes, pipes, and tunnels; diversion and storage dams; spillways and outlets; gates and valves; and fish protection. The volume contains basic information of value to engineering students and beginning and experienced engineers. The author is Ivan E. Houk. (John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1956. 531pp., bound. $14.00.)

Materials of Engineering

Basic information on metals, inorganic nonmetallic materials, and organic materials, presented concisely and with emphasis on practical applications. About three-quarters of the book is devoted to metals, the remainder to such materials as clay, glass, gypsum, concrete, plastics, rubber, organic coating, and wood. Carl A. Keyser is the author. (Prentice-Hall, Inc., Englewood Cliffs, N. J., 1956. 502pp., bound. $8.00.)

The Metropolitan Transportation Problem

This is a broad and critical survey by Wilfred Owen, covering such aspects of the subject as trends in population and economic activity; the failure of urban planning to take into account the increased use of private vehicles; the decline of mass transportation; current attempts to remedy the situation by expressways, terminals and off-street parking; methods of financing and organizing transportation systems; and city redevelopment. The author sees the solution to the problem in a program combining metropolitan redevelopment and the coordinated utilization of all methods of transportation. The Brookings Institution, 722 Jackson Place, N. W., Washington 6, D. C., 1956. bound. $4.50.)

Our Nation's Water Resources—Policies and Politics

Five lectures by Ben Morcell, former chairman of the Task Force on Water Resources and Power of the Second Hoover Commission. Four of the lectures deal with past and present federal water policies; the administrative agencies concerned with water resources and power; and federal developments in navigation, reclamation, flood control, and power. The fifth lecture is a summary of the findings and recommendations of the Task Force. (Published by The Law School, The University of Chicago, Chicago 37, Ill., 1956. 266pp., bound. $3.50.)

Pluie, Evaporation, Filtration et Ecoulement

(Société Hydrotechnique de France, Troisiemes Journées de L'Hydraulique, Alger, 1954).

A group of 40 papers covering a wide range of topics in the field of hydrology: relations between various measurements, of precipitation, evaporation, run-off, etc.; relation between surface flow and subterranean flow; statistical hydrology; soil permeability; reservoir silting; application of electric analogy to hydraulic flow. These are some of the more important subjects. Many papers relate to specific problems in defined areas. Each paper has an English abstract. (La Houille Blanche, Grenoble, France, 1955. 316pp., paper. Francs 4,000.)

Railway Track and Structures Cyclopedia

The present revision of this reference volume, previously published as the Railway Engineering and Maintenance Cyclopedia, has been revised to include the latest information on practices, materials, equipment, tools, and appliances used in the construction and maintenance of track, bridges, buildings, water service, signals, and other fixed properties and facilities. A directory of products, a trade-name index, and an alphabetical list of manufacturers are given at the end of the book. (Simmons-Boardman Publishing Corporation, 30 Church Street, New York 7, N. Y., Eighth edition, 1955. 854pp., bound $12.00.)

Route Surveying

A presentation of basic principles and their applications in curve or earthwork problems by Carl F. Meyer. More than half of the book consists of tables set up in a form especially useful in route-survey calculations. In the revision, a chapter on the use of aerial photography has been added, some chapters have been rewritten, and minor changes have been made in most of the other chapters. (International Textbook Company, Scranton 9, Pa. Second edition, 1956. 320pp., bound. $7.50.)

Symposium on High-Purity Water Corrosion

(Special Technical Publication No. 179)

Three of the five papers included are concerned with the corrosion problem in connection with high-temperature, high-purity water: the influence of water composition, the effect of material composition, and the corrosion of carbon and low alloy steels. The other two papers deal with the preparation and maintenance of high-purity water and the use of water in atomic reactors. (The American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1956. 56pp., paper. $1.75.)

Timber Design and Construction Handbook

The greater part of this handbook is devoted to the principles and practical methods of design for basic members and joints and for roof trusses, arches, framing, piers and wharves, bridges, and other structures. This design section also includes a chapter on the properties and applications of plywood, and a chapter covering fabrication, assembly, erection, and maintenance. The remainder of the book consists of two chapters on the fundamental structure and characteristics of wood, and an extensive section of reference data. Prepared by Timber Engineering Company. (F. W. Dodge Corporation, 119 West 40th Street, New York 18, N. Y. 1956. 622pp., bound. $12.75.)

Library Services

Engineering Societies Library books may be borrowed by mail by ASCE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply photoprint or microfilm copies of any items in its collections. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N.Y.

Non-ASCE Meetings

American Concrete Institute. Fifty-third Annual Convention at the Statler-Hilton Hotel, Dallas, Tex., February 25-28, 1957. Information from Cedric Willson, vice-president, Texas Industries, Inc., Dallas.

American Concrete Pipe Association. Forty-ninth Annual Convention at the Shoreham Hotel, Washington, D. C., March 5-9, 1957. Information from Howard F. Peckworth, managing director, American Concrete Pipe Association, 228 North LaSalle St., Chicago 1, Ill.

American Institute of Mining, Metallurgical, and Petroleum Engineers. Annual Meeting at the Roosevelt Hotel and Jung Hotel, New Orleans, La., February 24-28, 1957. Information from AIME, 29 West 39th Street, New York 18, N. Y.

American Road Builders Association. ARBA Convention and Road Show at the International Amphitheatre in Chicago, Ill., January 28-February 2, 1957. Information from Harvey A. Scribner, Chairman of the Road Show Publicity Committee, 155 North Wacker Drive, Chicago 6, Ill.

American Society of Photogrammetry. American Congress on Surveying and Mapping. 1957 ASP-ACSM Consecutive Meetings and Co-Exhibit for the seventeenth Annual Meeting of ACSM and the Twenty-third Annual Meeting of ASP at the Shoreham Hotel in Washington, D. C., March 3-9, 1957. Information from ASP-ACSM, 1515 Massachusetts Avenue, N. W., Washington 5, D. C.

Engineers Joint Council. Third Annual Assembly at the Hotel Statler, New York, N. Y., January 17-18, 1957. Information from EJC, 29 West 39th Street, New York 18, N. Y.

Georgia Institute of Technology. Sixth Annual Georgia Highway Conference at the Georgia Institute of Technology, Atlanta, Ga., February 25-26, 1957. Information from Radner J. Paquette, Professor, School of Civil Engineering, Georgia Institute of Technology, Atlanta, Ga.

Louisiana State University. The 1957 Conference on High-Speed Computers at the University, Baton Rouge, La., March 5-8, 1957. Information from Dr. J. W. Brouillette, Director, General Extension Division, Louisiana State University, Baton Rouge 3, La.

National Society of Professional Engineers. Spring Meeting at Hotel Francis Marion, Charleston, S. C., February 15-16, 1957. Information from NSPE, 2029 K Street, N. W., Washington 6, D. C.

Nuclear Congress. 1957 Nuclear Congress sponsored and conducted by twenty leading engineering and scientific societies under the coordination of Engineers Joint Council at Convention Hall, Philadelphia, Pa., March 11-15, 1957. Information from EJC, 29 West 39th Street, New York 18, N. Y.

Society of the Plastics Industry, Inc. Twelfth Annual Technical and Management Conference of The Reinforced Plastics Division at the Edgewater Beach Hotel, Chicago, Ill., February 5-7, 1957. Information from the Society of Plastics Industry, Inc., 250 Park Avenue, New York 17, N. Y.

Society of Automotive Engineers, Inc. Annual meeting and engineering display at the Sheraton-Cadillac Hotel and Hotel Statler, Detroit, Mich., January 14-18, 1957. Information from SAE, 485 Lexington Avenue, New York 17, N. Y.

University of Illinois College of Engineering. Forty-third Annual Illinois Highway Engineering Conference at the University, Urbana, Ill., February 26-28, 1957. Ninth Annual Illinois Traffic Engineering Conference at the University, Urbana, Ill., February 28-March 1, 1957. Information from John W. Hutchinson, Instructor, Department of Civil Engineering, University of Illinois, Urbana, Ill.

U. S. Geological Survey. Eastern Snow Conference, 14th Annual Meeting at the Onondaga Hotel, Syracuse, N. Y., February 7-8, 1957. For information address the secretary: Dean B. Bogart, Box 948, Albany 1, N. Y.

Positions Announced

Bureau of Reclamation. Openings are announced for Student Trainees (Civil Engineering) Grade GS-4, $3,415 per year. Excellent opportunity for interesting work in public service with high-grade professional personnel and promotional opportunities to higher paid positions of greater responsibility. Standard Form 57, available at any post office or Federal Agency, should be completed and submitted to United States Civil Service Commission, Central Board of United States Civil Service Examiners, Bureau of Reclamation, Denver, Colo.

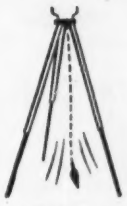
U. S. Civil Service Commission. Examinations will be given for Highway Engineer Trainee, Grades GS-4 and 5 for duty in the Bureau of Public Roads throughout the United States, salaries $3,415 and $4,480 per year. Highway engineer Grades GS-5 for duty in various Federal Agencies, salary $4,480 per year. Apply to Executive Secretary, Board of U. S. Civil Service Examiners, c/o Bureau of Public Roads, Washington 25, D. C.

U. S. Corps of Engineers. The Sacramento District has openings for Civil, Structural and Hydraulic engineers, grades GS-812-9 and 11, GS-810-9 and 11 and GS-813-9 and 11, in connection with the planning, design and construction of military and civil projects. Standard Form 57, available at any post office or Federal Agency, should be completed and submitted to the District Engineer, Sacramento District, P. O. Box 1739, Sacramento 8, Calif.

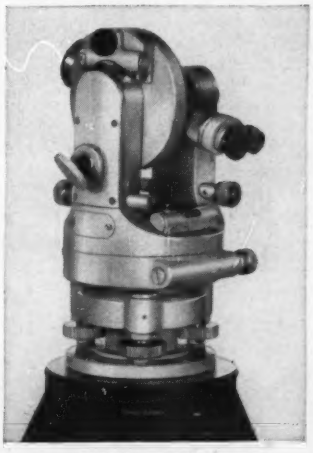
San Diego County. Two immediate openings in the Planning Department are announced. Both of these positions offer excellent opportunities for experienced planners. Salary $507 to $559 monthly. A description of the duties and responsibilities will be provided upon request from the Department of Civil Service and Personnel, Room 402, Civic Center, San Diego 1, Calif.

SURVEYING NEWS

NEW THEODOLITE SETS UP QUICKLY, EVEN IN THE WIND



Has this been your problem? Now—old-type mechanical plumb-bob replaced by can't-miss optical principle



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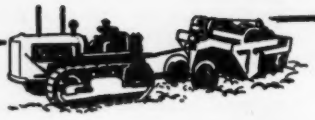
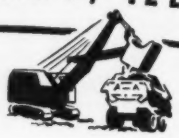
ARBA ROAD SHOW Previews

JAN. 28 – FEB. 2 CHICAGO, ILL.





Land Clearing Equipment

THE FLECO EXHIBIT WILL feature the latest in land clearing equipment designed to boost the capacity of crawler tractors. On display will be a giant D9 Rake built to match the power and strength of the Cat D9 Tractor. This massive rake stands 6-ft, 4-in. high and 14-ft, 6½ in. wide (for the angling dozer frame) and is designed to push out trees, brush, stumps and rake material into dirt-free piles. Under many conditions the Fleco Rake can increase the clearing capacity of the D9 by as much as 50%. Mounted at the rear of the D7, the Fleco Pull Stumper is operated independently of front mounted equipment on tractors equipped with double drum cable control units. The heavy cast steel tooth can be used to cut big lateral roots on trees or stumps. Then the tooth is hooked over the stump and forward tractor motion pops the stump out of the ground, tap root and all. **Fleco Corp., CE 1-132, Jacksonville, Florida.**

D9 Rake

Baseal

AN ENTIRELY NEW ITEM to their line and which is to be displayed at the Road Show, is Servicised's Rubber Baseal. Designed for use in eliminating water seepage through expansion and contraction joints in concrete pavements, Baseal stops pumping action which causes failure of pavement at joints.

It is available in continuous lengths of 26-ft, standard width 6-in. Made in two types, No. 5309 is designed for sawed or formed transverse contraction joints and No. 5310 designed for transverse expansion joints.

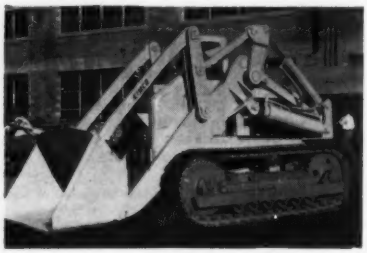
Placed over compacted base prior to paving in transverse position, Baseal, due to its resilient characteristics, will conform to the terrain after concrete is poured. **Servicised Products Corp., CE 1-132, 6051 West 65th St., Chicago, Ill.**

Fibre Forms and Tubes

EMPHASIZING THEIR ADAPTATIONS to bridge and highway construction, the Sonotube Fibre Forms for round columns of concrete and Sonovoid Fibre Tubes for voids in concrete construction, will be exhibited. Available from 2-in. inside diameter up to and including 48-in., Sonotube is particularly adaptable for columns for overpasses, bridge approaches, etc. The Sonovoid has been used in cast-in-place bridges, precast bridge decks, and in the formation of precast, prestressed hollow piles. **Booths 35 and 36, Sonoco Products Co., CE 1-132, Hartsville, S. C.**

Front End Loader

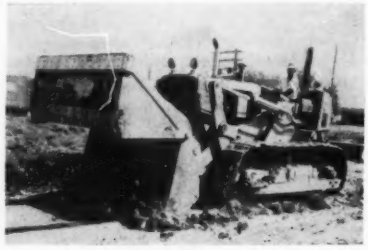
THE PRODUCTION OF ITS 105 Front End Loader, which is designed as a companion piece to the Eimco 105 Tractor-Excavator, is announced. Both are attachments to the Eimco Tractor. The attachment complements the other machine in many fields that had not been open previously. For instance, where head room clearance was not sufficient to swing the overhead bucket, the Front End Loader will operate in 9-ft 6-in. head room. This is also the case in many tunnels and construction jobs. The unit will work in loading haulage equipment at a point where the trucks are maintained at an elevation above the working area for the loader, will dig off high banks and also will handle the fine, dusty materials. The loader has a high pivot point on the bucket, in full extended position, so that although the dumping height is 11-ft 6-in., it can reach over a 14-ft high bin, hopper or railroad car to discharge its load. This machine will be applicable in cleaning out open-hearth slag furnaces or any other place where a strong downward pressure is necessary. **Eimco Corp., CE 1-132, Salt Lake 10, Utah.**



Model 105

Skid-Shovel

THE NEW 3-YD International Drott TD-18 Four-in-One Skid-Shovel has proven able to do as much work as 3 power shovels and a dragline digging up and loading old concrete, according to a contractor, Henry E. Berghuis, who is using the highly versatile 134-hp unit on a highway job. The rig, which converts from a 3-yd Skid-Shovel to a 3-yd Clamshell, a 3-yd Bullclam, and a giant capacity Bulldozer, was used to handle 1,700 lineal ft of old pavement daily and load out 4,500-yd of sticky, wet-jumbo material which had defied single purpose loaders.



TD-18

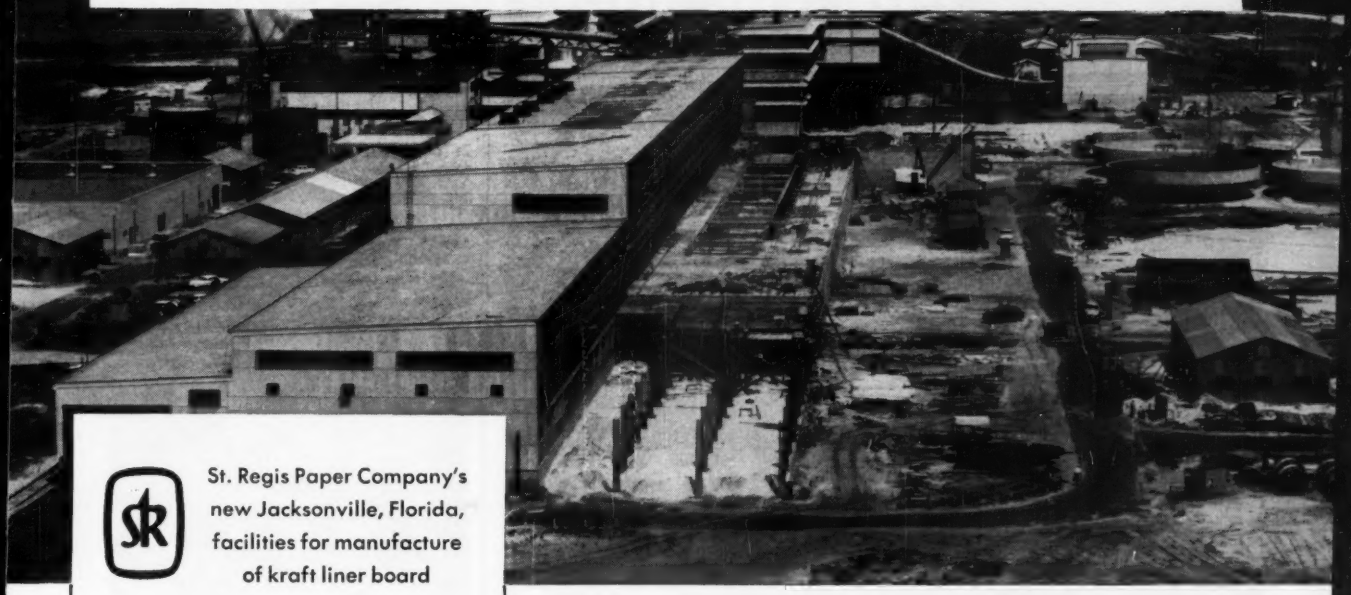
According to engineers who designed and recently announced the huge TD-18 Four-in-One, the new unit features the use of T1 steel, a recent development by U. S. Steel. This steel, 80% stronger than hi-strength manten steel, cuts 45% of fabricating weights.

Four-in-One Skid-Shovels have been job tested and proved in the field on the International TD-6, TD-9, and TD-14 crawler tractors; for use by the small contractor, and now the new 3-yd TD-18 Four-in-One gives the big contractor the highest-producing, most flexible tractor-loader in the field today. **International Harvester Co., CE 1-132, 180 North Michigan Ave., Chicago 1, Ill.**

Bitumuls and Asphalts

THE UNIQUE ADVANTAGES of bitumuls and asphalt in all phases of highway construction will be the highlight of the American Bitumuls' display at the Road Show. Of special interest will be detailed, illustrated information on "Bitumuls Slurry Sealing," a recently-developed process of pavement rejuvenation which is receiving unusual attention throughout the industry. **Booths 81 and 82, American Bitumuls and Asphalt Co., CE 1-132, San Francisco, Calif.**

Down in Jacksonville—where St. Regis is spending $40,000,000 to expand its facilities



St. Regis Paper Company's new Jacksonville, Florida, facilities for manufacture of kraft liner board

—we're building a paper mill of steel!

With a modern pulp and paper mill located near Jacksonville, Florida, completed in 1952, already producing 350 tons of kraft paper and paperboard daily, St. Regis Paper Company is currently investing $40,000,000 in additional facilities which will enable the Jacksonville mill to produce an additional 1,000 tons of kraft liner board per day.

This is a big project involving the use of 5,000 tons of structural steel for the many large buildings and other structures required for the modern mill. All of this steel was fabricated and nearly all of it was erected by American Bridge.

The vast new mill was designed by J. E. Sirrine Company, Engineers, of Greenville, S. C., and Stevenson and Rubens, Consulting Engineers of Seattle, Wash. Tidewater-Auchter was the general contractor for the project.

In constructing this new mill for St. Regis, American Bridge utilized its experience, knowledge and skill to the advantage of everyone concerned with the project. All steelwork was erected with maximum speed, precision, economy and safety.

For detailed information regarding your structural steelwork requirements, please contact the office nearest you.

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Have you compared "DURAJOINT" with your present waterstop materials? If so, you have already found out that *only* "DURAJOINT" offers *all* of the following important features:

BEST MATERIAL..."DURAJOINT" is extruded from a specially compounded polyvinylchloride (thermo-plastic) material that will outlast the useful life of the structure it's used in.

BEST DESIGN..."DURAJOINT'S" special longitudinal ridges insure the distribution of critical pressures and enhance the holding power. The hollow center bulb assists in providing for extreme elongation with full recovery.

STRONGER..."DURAJOINT'S" extreme elasticity and excellent tear resistance allow it to successfully handle movement of masses of concrete without being sheared.

ECONOMICAL..."DURAJOINT" may be installed at a substantial savings in material and labor costs over other waterstop materials... easily installed by unskilled labor.

NATIONALLY DISTRIBUTED!

"DURAJOINT" enjoys national distribution through the outlets of Tecon Products Inc. in the 11 western states and W. R. Meadows, Inc. in the other 37 states of the mid-western, southern and eastern portions of the United States. Write today for complete information and name of your local distributor.

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ELGIN, ILLINOIS

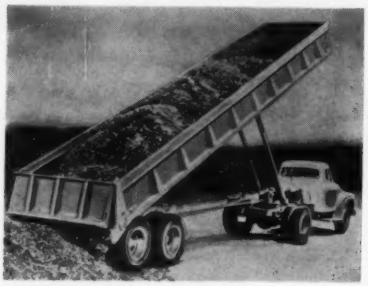
ROAD SHOW PREVIEWS

(continued)

Three New Units

FRUEHAUF WILL EXHIBIT THREE interesting new pieces of equipment. The new Carryall with removal gooseneck provides a quick and convenient front-end system for unloading heavy equipment. It does not require either a winch or hydraulic system to couple and uncouple the gooseneck.

The 20-ft volume dump trailer being shown is a tandem axle model of this very popular unit, also available in lengths up to 35-ft. This dump trailer is actuated by cable instead of the usual costly and heavy hydraulic hoist mechanism. As a result the number of moving parts has been reduced and considerable weight is saved, thus contributing to payload and profit.



20-ft Volume

The "Airslide" bulk cement trailer which is 18-ft long, uses the "Airslide" method of unloading which eliminates all mechanical contact with the load. Air from the engine-driven blower seeps through the fabric panels to actuate the load permitting it to flow over the panels which are tilted at 5 deg. This causes the load to progress to the low discharge point at the rear. **Fruehauf Trailer Company, CE 1-134, Detroit, Mich.**

Combination Float Finishers

THOROUGHLY TESTED ON controlled jobs this past season, Flex-Plane has announced that they are going into production on what they feel to be the finest concrete slab finishing machine yet developed. The machine combines the floating operation with the finishing. This combination enables the release of a man for other duties and it means that contractors can dispense with a machine. More important, the combination of these two operations results in a better slab finish, reducing the number of hand finishers required for final finishing. **Booth 719, Flexible Road Joint Machine Co., CE 1-134, Warren, Ohio.**

ROAD SHOW PREVIEWS

(continued)

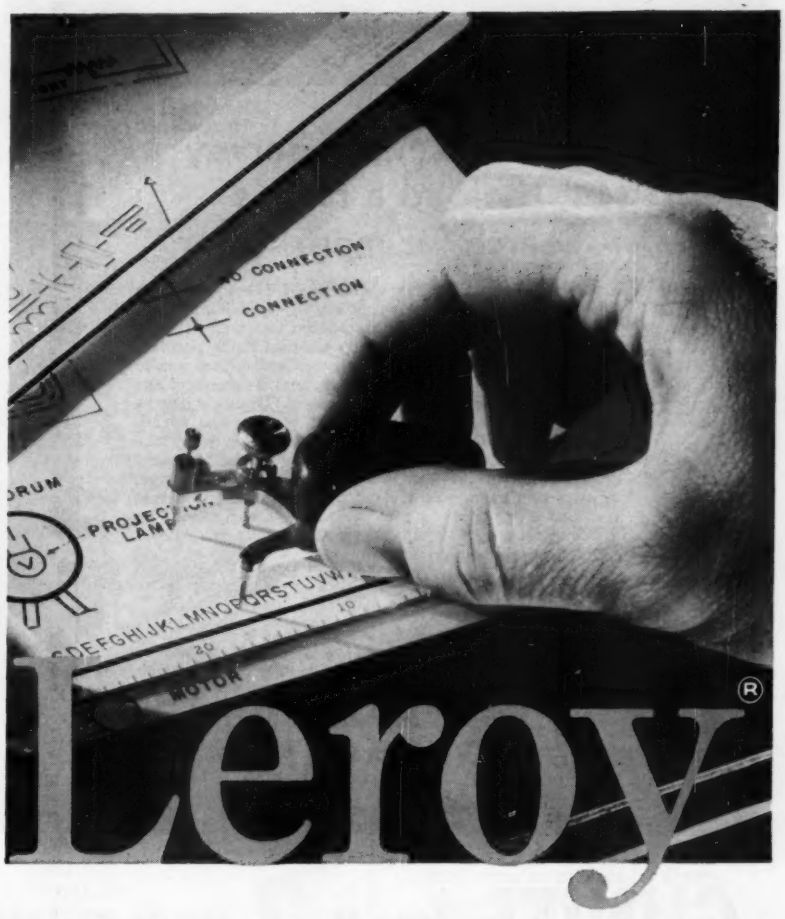
Wheel Ditcher

A NEW ADDITION TO Barber-Greene's extensive line of vertical boom and ladder-type Ditchers is the Model 774 Wheel Ditcher. Digging 5-ft 6-in. deep and to a maximum of 30-in wide, the model features a unique digging wheel construction designed to increase digging efficiency and to reduce any transmission of twist or tilt between the tractor and digging units. Simplified, hydraulic controls give faster response and lessened operator fatique. A floating differential, which raises and lowers with the wheel ensures balanced torque to drive teeth at both sides of the wheel. Improved crawler design, slipon digging teeth, guarded drive chains, reversible spoil conveyor, etc. are among a few of the other features of the machine. **Booth 722, Section D, Barber-Greene Co., CE 1-135, Aurora, Ill.**

Model 774

Mobile Laboraory

A COMPLETE MOBILE TESTING Laboratory was recently completed by a Chicago manufacturer of engineering test apparatus. The laboratory on wheels, designed and built for the Bureau of Public Roads, will be used on the Bureau's overseas road planning and construction projects. The laboratory is fully equipped for standard soil and concrete tests. Mounted on a Four Wheel Drive Auto Company truck, is has a van with inside dimensions of 16-ft long by 7-ft wide. Four engineers and testing technicians can work comfortably in the laboratory. The unit is designed to be self sufficient. It carries its own water supply, laboratory sinks, air compressor, air conditioner, vacuum pump and similar utility equipment. Power is supplied by an electric generating set which has sufficient capacity to light the laboratory and to operate all of the test appartus such as ovens, sieve shakers, heating plates, mixers and the utility equipment. **Soiltest, Inc., CE 1-135, 4711 W. North Ave., Chicago 39, Ill.**



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How a seismic survey helped a town's search for more water

Like many expanding towns, Greenfield, Mass., faced the problem of increasing its water supply by drilling wells. The problem was where to put down test wells. A Gahagan Seismic Survey Crew was called in. Using portable equipment they explored 1,870 feet of subsurface profile in one day. Mr. J. F. Collins, Supt. and Engineer of the Greenfield Water Department, states that seismic depths to bedrock agreed with subsequent test borings within 5 per cent in all cases. One 8-inch well driven by the Reversed Circulation Method gave an output of nearly 1,000,000 g.p.d. of excellent water. Mr. Collins says: "We were all very well pleased with your seismic survey, and feel that we saved considerable time and money by eliminating poor locations we would have test drilled." Write on your letterhead for Bulletin 2 "Geophysical Surveys", to Geophysical Survey Division, Gahagan Dredging Corporation, 90 Broad St., New York 4, N. Y.

Established in 1898, Gahagan is a leader in hydraulic dredging

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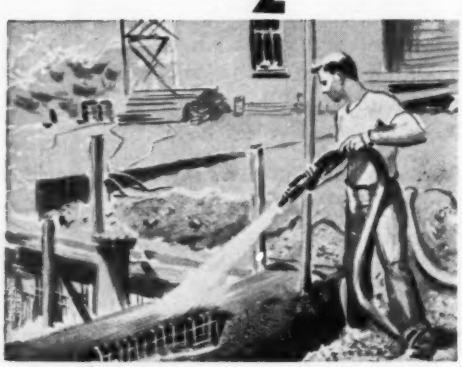

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ROAD SHOW PREVIEWS

(continued)

Multi-Purpose Machines

IN THEIR EXHIBIT AT Chicago, four Gradall multi-purpose construction machines and two Duplex trucks will be displayed. For the first time, the Duplex Division will introduce to the public its new four-wheel drive truck featuring a snow blade, a scraper blade, and a dump body. This truck has been developed to meet the growing need of the state, county, and municipal highway departments for snow removal and highway maintenance. The other truck to be exhibited is of the crane carrier type. Other products manufactured by the Duplex Division include a variety of special fire truck chassis and motor generators for supplying auxiliary electric power.

Standard Gradall

In the section of the exhibit devoted to the Gradall Division, four models of the Gradall will be displayed; a two-speed crawler model, a carrier mounted model, a self-propelled model, and a railroad model. These four models of Gradall have the same basic upperstructure construction.

The line of twenty Gradall attachments makes any of the four models adaptable to any construction or maintenance job. **Warner & Swasey Co., CE 1-136, Cleveland, Ohio.**

Special Services

CATERPILLAR'S EXHIBIT at the show will be one of the largest, with more than a million dollars worth of new and improved equipment covering more than 24,000-sq ft of floor space. Working cutaways will be included to show the design features of these products.

Thousands of contractors and highway officials from all over the world will be brought to the Show by Caterpillar Dealers. Typical of the interest in the Show is that in Sweden. A large transport has been chartered to fly a group of 55 directly to Chicago. The Sherman Hotel has been reserved entirely for Caterpillar Dealers with their guest contractors, officials and personnel. **Caterpillar Tractors, CE 1-136, Peoria, Ill.**

★ ★ ★ ★ ★

FIRST
STEEL MESH DECK
Still Making History!

The first installation of an open steel-grid flooring on any bridge in the world was made in 1932, on the University Bridge, Seattle, Washington, by the Irving Subway Grating Co. The previous solid pavement on the bridge had been plagued by frequent repairs and accidents.

After 24 years this decking is still in service on the Seattle Bridge. It has had no major repairs and has never even been painted. Not a single accident has occured due to the bridge flooring.

Since then, 80% open Irving Decking has been used advantageously on hundreds of other bridges.

This remarkable record of service speaks for itself.

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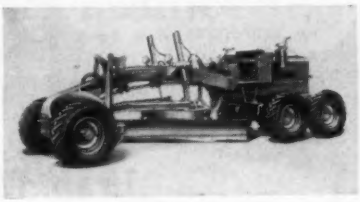
ROAD SHOW PREVIEWS

(continued)

Newly-Designed Line

THE DISTINCTION OF HAVING a complete newly-designed line of construction equipment on display is claimed by Austin-Western Works.

Actually in the past 18 months A-W redesigned and engineered its entire line based on a threefold objective: more power, larger work capacity, faster operation. Top billing in the exhibit will be the completely new Super 99 Power Grader with the exclusive 6-wheel drive and 6-wheel steer and the optional torque converter. Largest and most powerful of the firm's four graders, the Super 99 incorporates all the positive features pioneered and developed by Austin-Western and found in power graders everywhere—such features as precision sideshift, high-lift blade, extreme blade reach, completely reversible blade and hydraulic controls.



Super 99

Co-starred will be the Four-by-Four (4-wheel drive and 4-wheel steer) 88-L Power Grader, smallest in the line. It has the full complement of time-tested features embodied in all A-W power graders.

The Super 88 (6-by-6) and the 99-L (4-by-4) power graders round out the line. **Booth 702, Austin-Western Works, CE 1-137, Baldwin-Lima-Hamilton Corp., Aurora, Ill.**

Trucks

EIGHT INTERNATIONAL TRUCK models especially adapted for highway construction work will be displayed. The company, national leader in heavy-duty and six-wheel truck sales for more than 21 years, builds the most complete line of trucks in the world.

The IH display will point up the wide range of their models, with emphasis on truck-to-job specialization in the road building field. Also featured will be an elaborate "live" cutaway of the company's new V-8 engine, an exposed six-wheel-drive chassis, a moving six-wheeler "bogie-action" unit, and a diesel engine cutaway. **International Harvester Co., CE 1-137, Chicago 1, Ill.**

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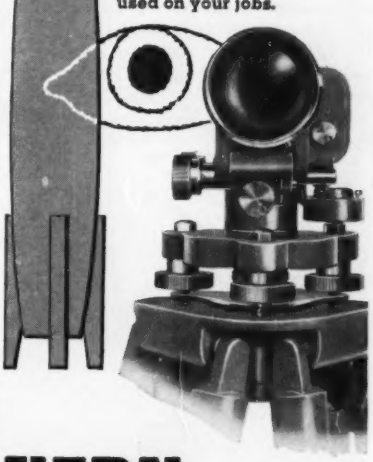
Obsolete surveying tools are time-consuming, wasteful ... out of step with modern construction equipment used on your jobs.



KERN THE MOST MODERN surveying instruments available. Down-to-fundamentals, functional design ... maximum operational efficiency and portability ... reliable precision results.

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for accuracy, speed, reliability, economy.

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ROAD SHOW PREVIEWS

(continued)

Earthmovers

SEVERAL COMPLETELY NEW machines and other models with major improvements that will be shown publicly for the first time are among the 16 earthmovers being exhibited. The 20,000-sq ft display will include scrapers, crawler tractors, rear dumps and bottom-dumps.

Two scrapers of 24-cu yd struck capacity head the group. The Twin-Power, all-wheel drive TS-24 model is equipped with two engines (518 total hp), each driving an axle through a separate Allison Torqmatic Drive. This scraper works efficiently either with pushers or independently under the most adverse job conditions. A new 6-wheel, single engine scraper with 300-hp, Model SS-24, provides the stability needed for long, high-speed hauls.

Model SS-24

The new Model SS-18 Scraper, with 18-yd struck capacity, also has a 4-wheel single engine tractor powered by a 300-hp engine. Another 18-yd scraper, the improved Model S-18, provides even better performance than before with a new 4-speed Torqmatic Drive and newly designed 300-hp engine with Roots Blower.

Latest production models of two other Euclid Scrapers will be on display: Model S-7 with 143-hp engine and 7-cu yd struck capacity and a 12-yd size, Model S-12 with 218-hp. **Euclid Division, General Motors Corp., CE 1-138, Cleveland 17, Ohio.**

Bros Roto-Mixer

THE ROTO-MIXER is a powerful machine designed to mix, pulverize, blend and stabilize all types of soils and aggregates. It mixes at any depth down to 12" and at any width up to 7'. Both sides of rotor are coupled to power unit with a heavy chain drive. Final drives are enclosed in dirt-proof housings. Height of rotor and hood are hydraulically and independently controlled. The big, rugged mixing tools are securely fixed in load absorbing sockets, and are changed quickly and easily by removal of single bolt. Two types of tools are available, one for heavy chopping, the other for lighter reclaiming or mixing. **Wm. Bros Boiler Mfg. Co., CE 1-138, Minneapolis, Minn.**

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ROAD SHOW PREVIEWS

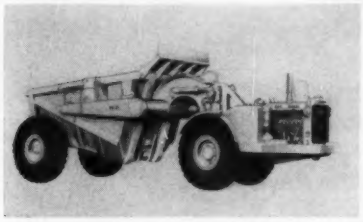
(continued)

Trailers and Loader

THREE BASIC ROAD BUILDING and material handling machines are being exhibited. They are the Athey PR21 Rear Dump Trailer, PR15 Rear Dump Trailer and 125 HiLoader.

The PR21 is a 22.5-cu yd rear dump trailer and is a flexible, articulated design hauler that permits unrestricted maneuverability, ease of operation and stability impossible with trucks. Behind the Caterpillar DW21 Tractor, it can turn non-stop in a 27-ft circle with body up, and in a 34-ft circle with body down. The PR21 is built extra-rugged for shovel loading and for high-speed operation over rough haul roads.

Another high-speed hauler, the PR15, a 15.6-cu yd is a matched companion to the 4-wheel Cat DW15 tractor. It can make 15-deg, non-stop turns in a 37-ft diameter. Top speed of the unit is 31.3 mph.



PR21 with Cat DW21

The third machine at the exhibit is the Athey 125 HiLoader. This self-propelled, belt-conveyor loader puts loading on a continuous, assembly-line basis. The 125 has a capacity of up to 10-cu yd per minute in loading stockpiled or windrowed construction materials such as sand, gravel, stone or cinders, and handles up to 25-cu yd per minute of snow. Patented full-floating feeder keeps a continuous flow of material going up the belt. Powerful 130-hp engine, big traction-giving tires and four low-gear speeds give exactly the right combination of crowd for high-efficiency loading. **Booth 701, Athey Products Corp., CE 1-139, 5631 West 65th St., Chicago 38, Ill.**

Crane Carriers

COMPLETION OF THEIR PLANS to participate in the forthcoming Road Show has been announced. According to company spokesmen, the latest Bantam equipment will be on display, including the heavy-duty 7-ton crane carrier mounted Model T-35, the crawler mounted Model C-35 and the new self-propelled Model CR-35. In addition, a complete line of attachments will be shown to illustrate the all-job versatility of their equipment. **Booth 731, The Schield Bantam Co., CE 1-139, Waverly, Iowa.**

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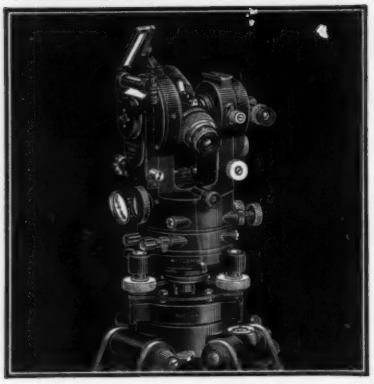

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ROAD SHOW PREVIEWS

(continued)

Black Topper

A NEW BLACK TOP PAVER finisher for off-the-highway and other use will be introduced and contractors will get their first glimpse of the paver at the Road Show.

The machine has been named the Black Topper, model PF-45. Mechanically, and in appearance, it's a "little brother" to the Blaw-Knox PF-90, being a half-size version of that model, but it will do more than half the work. It is 14-ft long and has a base width of 11-ft and is equipped with two 10:00 by 15, 14-ply pneumatic tires on the drive wheels. Front wheels under the 4-ton, 10-ft wide hopper are solid rubber tired 24 x 4 x 20-in., two such tires per wheel.

Powered by a Continental F-162 engine which develops 30-hp at 1,500 rpm, the machine has six working speeds and a high travel speed of 8 mph.

The maximum width of the screed is 11-ft. Sections of the screed can be blocked or removed to pave down to 8-ft widths. Hydraulic controls lift the screed for 8½-in. clearance. A propane system, which is available as an extra, provides screed heat. Tamping action is vertical with a speed of 1,000 rpm at 1,300 engine rpm. A v-belt with clutch drives the screed. **Blaw-Knox Co., CE 1-140, 300 Sixth Avenue, Pittsburgh 22, Pa.**

High Strength Wire Ropes

MANY OF THE LATEST innovations in road building accessories such as VHS drag lines, shovel hoist ropes, scraper and dozer cable as well as boom cable assemblies will be displayed.

Representing ACCO at this important trade exposition will be the American Cable Division and the Hazard Wire Rope Division, both of Wilkes-Barre, Pa.

Interest of the exhibit will be centered around the Divisions' line of VHS wire ropes, ACCO Registered boom cables and Cable-Laid wire rope slings. The VHS line represents a new high strength wire rope, at least 15% stronger and more wear-resistant than the best grade of wire rope available in the past. This grade of rope has made greater safety factors possible in equipment design with no increase in rope diameter and consequently no increase in over-the-road equipment weight. For tough jobs, field reports from users indicate new high in service life. Up to 60% longer life in VHS drag lines and VHS shovel hoist rope are an accepted fact. **Booth 357, American Chain & Cable Co., Inc., CE 1-140, 929 Connecticut Avenue, Bridgeport 2, Conn.**

Motor Graders and Rollers

THE GALION EXHIBIT WILL feature the very latest advancements in motor graders and rollers, which will be of high interest to contractors and public officials. Included in the display will be the T-700 Grade-O-Matic motor grader, claimed to be the world's largest, heaviest, and most productive grader; and the Roll-O-Matic 14—20 ton 3-axle tandem roller. Both these units will draw much attention because they are said to be especially suited for the tough work schedules and service conditions which will be presented on much of the huge U.S.A. 13-year road building program. Other equipment on display at the show will include models T-600 Grade-O-Matic, 118, and 503 motor graders; their 8—12 ton tandem, 12—16 ton "Chief" 3-wheel Roll-O-Matic rollers, and the 4—6 ton portable tandem roller with retractable wheels. **Booth 726, Galion Iron Works & Mfg. Co., CE 1-140, Galion, Ohio.**

Scraper

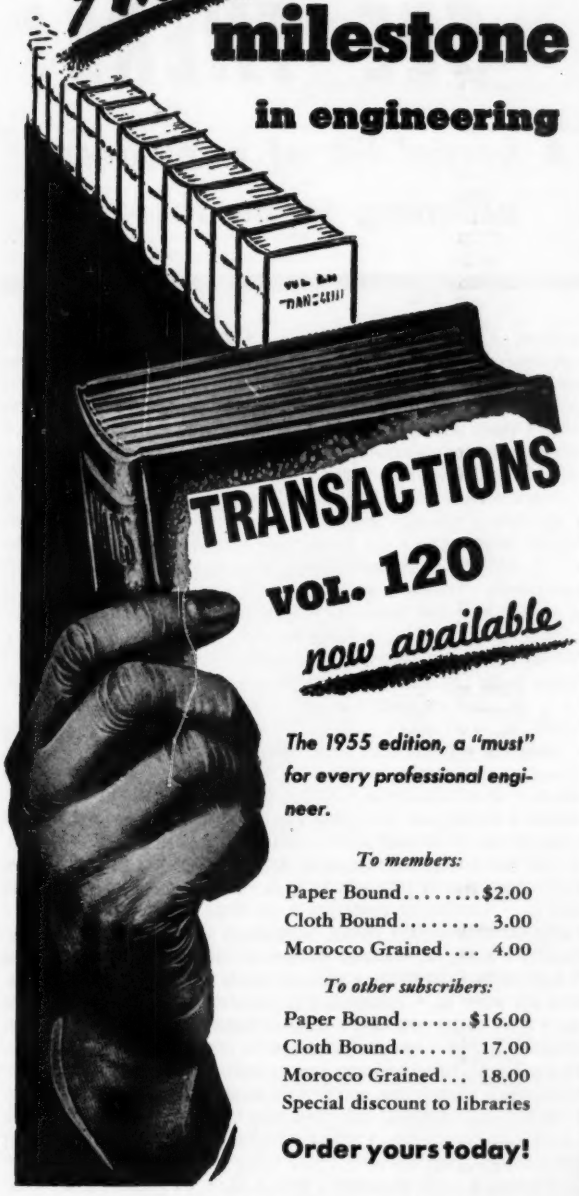
FEATURE REPRESENTATION of the complete scraper line at the Road Show will be an advanced model of the Cobrette self-propelled scraper in the 7.5 to 10-yd class. Officials indicate that it will incorporate at least two major elements never before offered in this class of equipment, in addition to a number of refinements in overall design.

The Cobrette was introduced early in 1956. It is the first unit built to provide

Cobrette

"team loading," having a special push plate integral with the main frame to allow one unit to help push-load a companion Cobrette. A positive "Gear Steer" actuated by rotary hydraulic cylinders, fluid coupling drive, air actuated clutch and power control unit, and a readily accessible gear transfer case that allows change of gear ratios in the field without extra parts, are among features introduced. **Wooldridge Mfg. Division, CE 1-140, Sunnyvale, Calif.**

Another milestone in engineering



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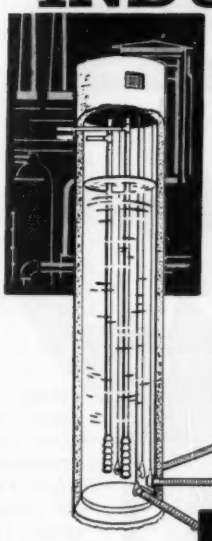
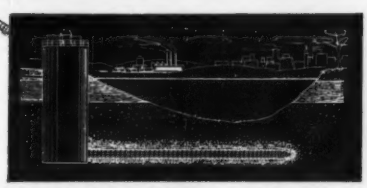


Conventional Collector. Proven by industries the world over, the collector that yields more naturally filtered water, with less equipment, less personnel, and fewer pumps than any other conventional collector.



Infiltration Gallery. The gallery, engineered by Ranney, provides industry a low cost water supply. The gallery provides large quantities of clear non-turbid water in a revolutionary yet economical way, and it requires no maintenance.

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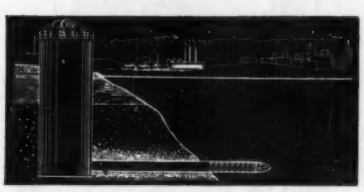
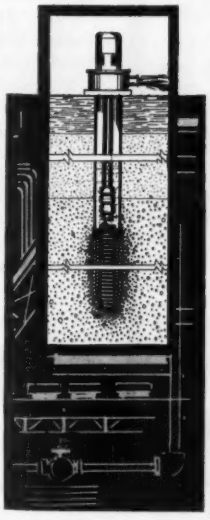
Mead Corp.
MacMillan & Bloedel Ltd.
E.I. DuPont de Nemours & Co.
Olin Mathieson Chemical Corp.
Timken Roller Bearing Co.



Ranney Intake. The Ranney Intake, already has proven that plants and factories can obtain surface water both efficiently and economically. The Ranney Intake can usually fit into the design of your engineering department or consultant.



Ranney Vertube. Small industry and low volume users can now have a natural gravel vertical water well at low cost. Engineered with the same Ranney precision that has made their method a *must* for industry.

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Hear internationally-known authorities report on the latest advancements in construction—lead dicussions about new ideas—present details of the hugh vital road program.

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See machines at work, actually doing the jobs which you face each day. See methods proved before your eyes.

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The contacts you make will prove of inestimable value. Experts from every part of the world—every one ready to talk about your problems.

WHO YOU'LL SEE THERE!

A partial list of exhibitors planning to be there

ACME IRON WORKS • AEROIL PRODUCTS COMPANY, INC. • AEROQUIP CORPORATION • ALLEN INDUSTRIAL PRODUCTS, INC. • ALLIS-CHALMERS MANUFACTURING CO. • AMERICAN BOSCH DIVISION (AMERICAN BOSCH ARMA CORPORATION) • AMERICAN CHAIN & CABLE COMPANY, INC. • AMERICAN HOIST & DERRICK CO. • AMERICAN MANGANESE STEEL (DIVISION OF AMERICAN BRAKE SHOE CO.) • AMERICAN TRACTOR CORPORATION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • ATHEY PRODUCTS CORPORATION • AUSTIN-WESTERN COMPANY • BALDWIN-LIMA-HAMILTON CORPORATION • BARBER-GREENE COMPANY • BARCO MANUFACTURING CO. • BAY CITY SHOVELS, INC. • BLAW-KNOX CO. • WM. BROS. BOILER & MFG. CO. • J. I. CASE COMPANY • CATERPILLAR TRACTOR CO. • CHAIN BELT COMPANY • C. H. & E. MANUFACTURING CO. • CHEVROLET MOTOR CORP. (TRUCK & COMMERCIAL DEPARTMENT) • CHICAGO RAWHIDE MANUFACTURING COMPANY • CHRYSLER CORPORATION (DODGE DIVISION) • C.I.T. CORPORATION • CLARK EQUIPMENT COMPANY • CLEAVER-BROOKS COMPANY • THE CLEVELAND GRAPHITE BRONZE COMPANY • CLEVELAND TRENCHER COMPANY • CONSTRUCTION MACHINERY COMPANY • CONTINENTAL MOTORS CORPORATION • COOK BROS. EQUIPMENT COMPANY • CUMMINS ENGINE COMPANY, INC. • DANA CORPORATION • BUCYRUS-ERIE COMPANY • BUDA DIVISION (ALLIS-CHALMERS MANUFACTURING CO.) • THE BUFFALO-SPRINGFIELD ROLLER CO. • BUTLER BIN CO. • THE EIMCO CORPORATION • ELECTRIC STEEL FOUNDRY COMPANY • ELECTRIC WHEEL COMPANY • E. D. ETNYRE & CO. • EUCLID DIVISION (GENERAL MOTORS CORPORATION) • FORD MOTOR CO. • FRUEHAUF TRAILER COMPANY • FULLER MANUFACTURING CO. • THE GALION IRON WORKS & MFG. CO. • GAR WOOD INDUSTRIES, INCORPORATED • GENERAL ROAD MACHINES, INC. • GMC TRUCK & COACH DIVISION (GENERAL MOTORS CORPORATION) • GOOD ROADS MACHINERY CORPORATION • DETROIT DIESEL ENGINE (DIVISION GENERAL MOTORS CORP.) • DIAMOND IRON WORKS, INC. (GOODMAN MANUFACTURING COMPANY) • R. E. DIETZ COMPANY • EAGLE IRON WORKS • THE FRANK G. HOUGH CO. • HUBER-WARCO COMPANY • HYATT BEARINGS DIVISION (GENERAL MOTORS CORPORATION) • HYSTER COMPANY • INGERSOLL-RAND CO. • INTERNATIONAL HARVESTER CO. • IOWA MANUFACTURING CO. • JACKSON VIBRATORS, INC. • THE JAEGER MACHINE COMPANY • THE JEFFREY MFG. CO. • THE C. S. JOHNSON COMPANY • JOY MANUFACTURING CO. • KALAMAZOO DIVISION (THE NEW YORK AIR BRAKE COMPANY) • KOEHRING COMPANY • KOHLER COMPANY • THE GORMAN-RUPP CO. • W. E. GRACE MFG. CO. • THE HANSON CLUTCH & MACHINERY CO. • HARNISCHFEGER CORPORATION • THE HELTZEL STEEL FORM AND IRON CO. • HENDRIX MANUFACTURING CO., INCORPORATED • HERCULES GALION PRODUCTS, INC. • HERCULES MOTORS CORPORATION • HETHERINGTON & BERNER, INC. • HIGHWAY EQUIPMENT CO., INC. • HOMELITE DIVISION (TEXTRON AMERICAN, INC.) • McKIERNAN-TERRY CORPORATION • MINNEAPOLIS-MOLINE COMPANY • MURPHY DIESEL COMPANY • N. P. NELSON IRON WORKS, INC. • NORDBERG MFG. CO. • NORTHWEST ENGINEERING COMPANY • THE OLIVER CORPORATION • LE ROI DIVISION (WESTINGHOUSE AIR BRAKE COMPANY) • R. G. LE TOURNEAU, INC. • LE TOURNEAU-WESTINGHOUSE COMPANY • LINK-BELT SPEEDER CORP. • LITTLEFORD BROS., INC. • MACWHYTE COMPANY • MARION POWER SHOVEL COMPANY • MASTER VIBRATOR COMPANY • SMITH ENGINEERING WORKS • STANDARD STEEL CORPORATION • STANDARD STEEL WORKS • STOW MANUFACTURING COMPANY • TAMPO MANUFACTURING CO. • THE TEXAS COMPANY (ASPHALT SALES DEPARTMENT) • THE THEW SHOVEL CO. • THE OWEN BUCKET COMPANY • PETTIBONE MULLIKEN CORP. • PIONEER ENGINEERING WORKS, INC. • PORTLAND CEMENT ASSOCIATION • JOHN A. ROEBLING'S SONS COMPANY • SCHIELD BANTAM COMPANY, INC. • SCHRAMM, INC. • SEAMAN-ANDWALL CORPORATION • SEAMAN ENGINEERING & RESEARCH CO. • S K F INDUSTRIES, INC. • THE WHITE MOTOR COMPANY • WOOLDRIDGE MANUFACTURING DIVISION (CONTINENTAL COPPER & STEEL INDUSTRIES, INC.) • THE TIMKEN ROLLER BEARING COMPANY • THE TORRINGTON COMPANY • TWIN DISC CLUTCH COMPANY • UNION CHAIN & MANUFACTURING COMPANY • UNION WIRE ROPE CORP. • UNIT CRANE & SHOVEL CORP. • UNITED STATES STEEL CORPORATION • WALTER MOTOR TRUCK COMPANY • THE WARNER & SWASEY COMPANY • WAUKESHA MOTOR CO. • WISCONSIN MOTOR CORPORATION • WORTHINGTON CORPORATION

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ROAD SHOW PREVIEWS
(continued)

Bituminous Mixing Plant

A PORTABLE BATCH TYPE bituminous mixing plant, the H-15, will be shown having a capacity range of 35 to 65 tons per hour, depending upon job specifications. The pugmill mixer has a capacity of 15-cu ft (net below center line of shafts).

The H-15 is a stack-up, tower-type plant consisting of a hot elevator, screen and bin section, batcher and mixer section, bitumen pump, jacketed bitumen piping and valve, stairway, platform, controls and drives. The plant is extremely easy to erect since the sections are self-contained units. After the base is set up, the batcher and mixer section with aggregate and bitumen scales and batchers connected is hoisted into position. Hot elevator, screen and bin section is then hoisted on top of the batcher-mixer section. Lower portion of hot elevator is raised into position and piping connected.

H-15

The H-15 is offered as a portable or stationary plant with a choice of combustion engine or electric motor drive. All gates and valves are operated manually thru mechanical linkage, except mixer discharge gate which has a manually controlled hydraulic cylinder. Optional equipment includes portable equipment, mineral filler attachment and electric timing and locking device. **Booth 723, Iowa Mfg. Co., CE 1-143, Cedar Rapids, Iowa.**

Transporters

A RADICALLY NEW TYPE of vehicle for transporting freight over rough open country, without benefit of highways or railroads, has just been introduced. So nimble are the new light-footed Transporters that the only roads they require may be through soft sand, powdery snow, deep mud, or dense underbrush. Even when loaded to their full 35-ton capacity, the giant trucklike carriers can take wide gullies and steep grades easily in stride.

Probably the most important single factor contributing to the success of the super-heavy haulers is the fact that a DC electric motor is geared directly to each wheel—making each individual wheel an independent drive unit. Should one wheel lose traction, its share of the machine's total horsepower is automatically transferred to other wheels which are taking hold. Also utilized is a unique braking system which actually has no parts to wear out or replace. This is made possible by a regenerative—or "feeding back"—action of the electric motors in the wheels. When machine travel-speed becomes greater than the driving speed of the motor, they begin acting as generators and, in effect, create power to stop Transporter and themselves. **R. G. LeToureau, Inc., CE 1-143, 2399 South MacArthur, Longview, Texas.**

Crane Excavator

A COMPLETELY NEW crane-excavator in the 1-yd class is being introduced this month. Named the model 30-B, it is a readily convertible shovel, dragline, clamshell, crane, or dragshovel. It is offered with five sizes of crawler mountings and is also available as a carrier-mounted Transit Crane, rated at 35 tons.

Main operating functions of the machine are air controlled. According to the manufacturer, proper graduation of air pressure gives the operator full-feel over his control levers. Air controlled functions include hoist clutch, crowd and retract or drag clutches, swing and propel clutches, steering jaw clutches, digging brakes, swing brake and dipper trip.

Model 30-B

The new 30-B crawler machine is available with Diesel engine with either direct drive or torque converter drive, gasoline engine with direct drive, or electric motor. **Bucyrus-Erie Company, CE 1-143 South Milwaukee, Wis.**

HOW TO HANDLE
WET JOBS

#35 of a Series

WELLPOINTS ELIMINATE SHEETING

Harbison-Walker Brick Refractory, Hammond, Ind. — *Contractor:* Consolidated Engineering & Construction Co.

WHEN A JOB-SITE is located, like this one, in the middle of a swamp —and when the water-bearing soil is a fine sand with an underlying layer of clay — it's not surprising that the contractor should figure on sheeting. Such expense, of course, runs heavy.

• Actually, in this case—as in many others which "look like" sheeting jobs—Griffin engineers were able to solve the problem far more quickly and economically with the use of wellpoints alone. Photo shows 2-stage system which successfully drained the 27 ft of ground water as required.

• Whatever your pre-drainage problems—power plants, pipelines, buildings, etc.—if you want lower costs for lowering water, it will pay you to check with Griffin, wellpoint specialists for over 2 decades.

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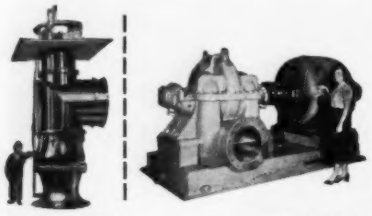
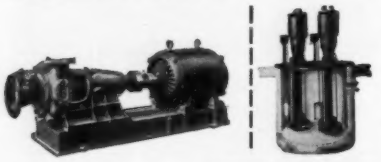


VERTICAL AXIAL FLOW FOR CIRCULATING CONDENSER COOLING WATER

DUAL VOLUTE FOR MUNICIPAL WATER WORKS

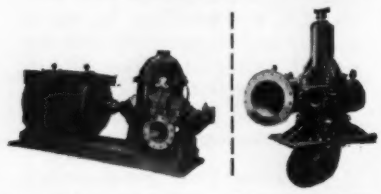
WHEELER-ECONOMY PUMPS



HORIZONTAL NON-CLOG FOR SEWAGE, TRASH, STOCK

DUPLEX, SUBMERGED NON-CLOG FOR SANITATION SEWAGE, INDUSTRIAL WASTE

WHEELER-ECONOMY PUMPS



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ECONOMY PUMP DIVISION

19TH AND LEHIGH, PHILADELPHIA 32, PA.

ROAD SHOW PREVIEWS

(continued)

Soil Compaction

SEVERAL NEW DEVELOPMENTS in low-cost equipment for grading, earth-moving and soil compaction will be introduced. In addition to the Duo-Pactor, introduced in mid-1956, the exhibit will feature the newly developed Duo-Grader and Duo-Scraper. All these units are of self-propelled design, with interchangeable prime mover. Thus, with only one prime mover, the contractor will be able to excavate, haul, fill, spread, compact, level and slope on highways, street, airport,

Duo-Pactor

and building construction work.

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(Continued on page 145)

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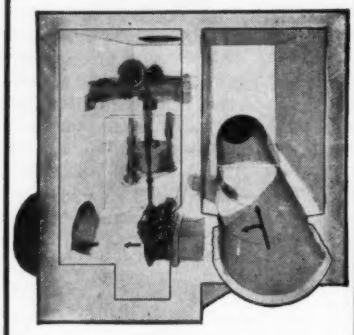

Fig. B-19

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(continued)

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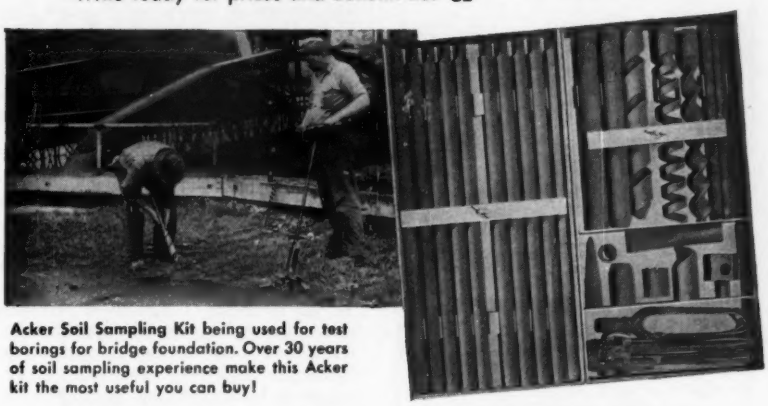

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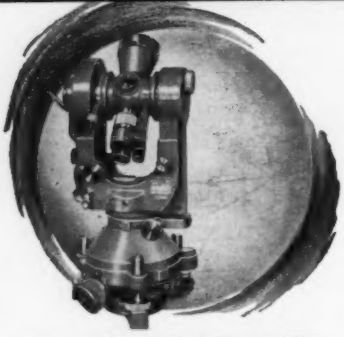

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SURVEYING METHODS—A bound publication is now available, which shows how to compute the survey of an area, tangent grade elevations, the sides and angles of a triangle, and square root. Mr. Carroll F. Merriam, past-president of the "American Congress on surveying and mapping" inspired this publication. He urged surveyors to change from logarithmic methods to new formulas and methods better adapted to modern calculating machines and has given many talks and prepared papers on computing method. **Friden Calculating Machine Co., Inc., CE-146, San Leandro, Calif.**

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PROCEEDINGS AVAILABLE

For instructions and key to abbreviations, see next page. Each member is entitled to 100 different "Proceedings Papers" yearly, ordered from these pages, plus all papers of the Technical Divisions in which he registers. The latter papers will be mailed automatically. Discussion of a paper will be received during the four full months following the month of issue.

November

1109. Airport and City Planning, by Leigh Fisher. (AT) The author, studying the thesis that there is insufficient correlation between planning for airports and regional development planning, analyzes the specific factors which should be considered to achieve better integration of the airport with the community it serves. Ground transportation, airport-to-community distance, approach zoning, noise nuisance, and land use are some of the factors considered.

1110. Discussions of Proceedings Papers 720, 987. (AT) Robert Horonjeff and John Hugh Jones closure to 720. Corrections to 987.

1111. Discussions of Proceedings Papers 705, 706, 728, 788, 884, 961. (IR) Howard T. Critchlow closure to 705. Robert O. Thomas closure to 706. A. R. Robinson and Carl Rohwer closure to 728. M. Gamal Mostafa closure to 788. D. M. Forester on 884. Frederick L. Hotes, Wendell E. Johnson and Charles A. Cocks, Eugene W. Weber on 961.

1112. Discussion on Proceedings Papers 680, 735, 829, 914, 916, 920, 973, 1019. (ST) Corrections to 680. Corrections to 735. Ephraim G. Hirsch and E. P. Popov closure to 829. Howard H. Mullins on 914. Corrections to 916. Leonardo Zeevaert closure to 917. R. B. Matthiesen and R. L. Moore on 920. R. K. L. Wen on 973. Cevdet Z. Erzen on 1019. Corrections to 1019.

December

1113. Fluid Resistance to Cylinders in Accelerated Motion, by S. R. Keim. (HY) Real fluid resistance to cylinders in nonuniform motion was investigated. A rational correlation was found to exist between the resistance coefficient and an acceleration modulus using Reynolds number and length-diameter ratio as parameters. Quantitative data used in the analysis was obtained by accelerating cylinders vertically from rest in water.

1114. Graphical Determination of Water-Surface Profiles, by Francis F. Escoffier. (HY) Tables of functions, such as those of Bresse and Bakhmeteff, which are used to estimate water-surface profiles in uniform channels, have been published from time to time. In the present paper a graphical method is developed which greatly facilitates the use of these functions.

1115. The Mechanism of Reaeration in Natural Streams, by Donald J. O'Connor and William E. Dobbins. (SA) Turbulent flow theory has been utilized to formulate the theory of reaeration in natural streams. Laboratory experiments and field studies were used to check and substantiate the theoretical formulas.

1116. Air Pollution Studies at University of California at Los Angeles: SED Report No. 10, Sanitary Engineering Research Committee, Air Pollution Section. (SA) This paper discusses an air pollution research project involving methods of air analysis, air pollution control devices, refuse-incineration problems, meteorological factors, a full-scale pollution test, and results of long-range air-pollution studies. An analysis is also presented of the first report of the air-pollution studies conducted at the University of California.

1117. Experience of the Bureau of Public Roads in Highway Surveys, by William T. Pryor. (SU) New methods and practices in surveying are now ready to fulfill present needs throughout all states in the rapidly expanding highway construction program. Ground survey methods cannot be *supplanted*, but can and should be *supplemented* by photogrammetry and aerial surveys to attain better surveys and highways in less time with fewer engineers.

1118. The Use of Photogrammetry to Civil Engineers, by William O. Baker. (SU) A discussion of the many uses of photogrammetry in aiding the civil engineers to design highways, water and sewerage systems, power transmission lines, airports, and city development. Savings in cost and time are illustrated by specific projects in which photogrammetric methods are used instead of conventional ground surveys.

1119. Anchorages for Large Tainter Gates, by A. H. Kenigsberg. (WW) In this paper are discussed novel-type anchorages, whose distinguishing features and economy derive from a single tie girder placed centrally within the spillway pier, a single anchor at the upstream end of the girder, and its downstream end in a concentric grouping with the inclined side arms of adjacent tainter gates.

1120. The Apalachicola River Basin Project, by C. P. Lindner. (WW) The federal project for the Apalachicola River Basin provides for improvement of the Apalachicola River for 9-ft navigation, 3 locks and dams (2 with power facilities), and a dam for flood control, power production, and stream flow regulation. Unique features of design and unusual construction problems are discussed in this paper.

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1121. The Development of the Cumberland River Basin, by Frank P. Gaines and John T. Dennison. (WW) The plan provides for a 9-ft navigation channel from the Ohio River to Carthage, Tennessee, a distance of over 300 miles. It also provides for substantial flood flow reductions in the Cumberland, Ohio, and Mississippi Rivers, and for over 1,000,000 kw of hydroelectric power capacity with an estimated output of over 3½ billion kwh annually.

1122. Modern Towboat and Barge Design, by Harry B. Dyer. (WW) A brief history of commerce on the Mississippi and Missouri Rivers is given, together with a discussion of improvements in towboat and barge design which have resulted in more efficient use of inland waterways.

1123. Current Trends in Ohio River Traffic and Equipment, by Charles F. Michiels, William F. Lail, and Robert E. Mytinger. (WW) This paper presents a brief history of navigation on the Ohio River; describes how traffic patterns and towing equipment characteristics affected the original plan of canalization; and discusses why current trends in traffic and equipment must be considered to be governing factors in the design of replacement navigation structures now being constructed.

1124. Discussions of Proceedings Papers 965, 975. (WW) Austin E. Brant, Ersel G. Lantz on 965. Corrections to 975.

1125. Discussions of Preceedings Papers 858, 859. (BD) D. C. Drucker on 858. L. E. Grinter closure to 858. Alfred L. Golze on 859. Benjamin A. Whisler closure to 859.

1126. Sanitary Engineering Research—The Role of Research Grants, by Harry A. Faber, Harvey F. Ludwig, and Harry G. Hanson. (SA) Research in sanitary engineering is vital for future developments in this field. Much of the research is sponsored by the United States Public Health Service through research grants from the National Institutes of Health. A general discussion of the research grant program is given.

1127. Knoxville Sewage Treatment Plant, by Kenneth V. Hill. (SA) A complete description with detailed design data of the Knoxville sewage treatment plants is given. A complete breakdown of the cost figures is given as well as the method for financing the system.

1128. Local Flood-Protection Projects, Ohio River Basin, by S. M. Bailey, R. E. Karlen, and Harry Pockras. (WW) Local flood protection projects consist of levees, concrete walls, traffic closures, interior drainage facilities, pumping plants, and channel improvements. General requirements for planning and design of the various parts of the projects are presented in this paper. Information is included as to the effectiveness of one of the projects during a flood.

1129. Discussions of Proceedings Papers 847, 1002. (SA) Nelson L. Nemerow closure to 847. Ralph Stone on 1002.

1130. Discussions of Proceedings Papers 740, 997. (PO) Charles E. Buettner and Paul A. Pickel closure to 740. Corrections to 997. Robert E. Glover on 997.

1131. Discussions of Proceedings Papers 1005, 1009. (HY) Corrections to 1005. Fred W. Blaisdell on 1009.

1132. Design of the Eklutna Project, Alaska, by Frank B. Cook and David L. Goodman. (PO) This paper describes the design of the Eklutna Project, a hydroelectric power development of the Bureau of Reclamation near Anchorage, Alaska. Included in the paper are a description of the over-all purpose of the project and a detailed summary of the design of the principal power facilities.

1133. Description of Repairs to Spillway Piers of Keokuk Dam, by Ralph L. Shelton and Frank L. Burgrabbe. (PO) This paper describes the rehabilitation of the spillway piers of this dam after more than 40 years of service. Deteriorated concrete was removed and replaced with temperature-reinforced concrete anchored to sound concrete of piers.

1134. Observed Behavior of Several Italian Arch Dams, by Dino Tonini. (PO) A summary of the results obtained from the analysis of deflection, strain, temperature, and other measurements on nine Italian arch dams is presented. The important way in which temperature changes influence arch dam behavior is shown. The results of testing for foundation modulus by seismic methods before, during, and after construction of arch dams are described.

1135. Abstracts and Index to Proceedings, Volume 82 (1956), by the Board of Direction. (BD) A list of abstracts and a subject and author index have been prepared for all Proceedings Papers published in 1956; the numbers covered are 861 to 1135. The subject headings used were taken from the names of the technical divisions of the Society; other headings were added when deemed necessary. By use of the author index, it is possible to trace all the discussion that a paper has received.

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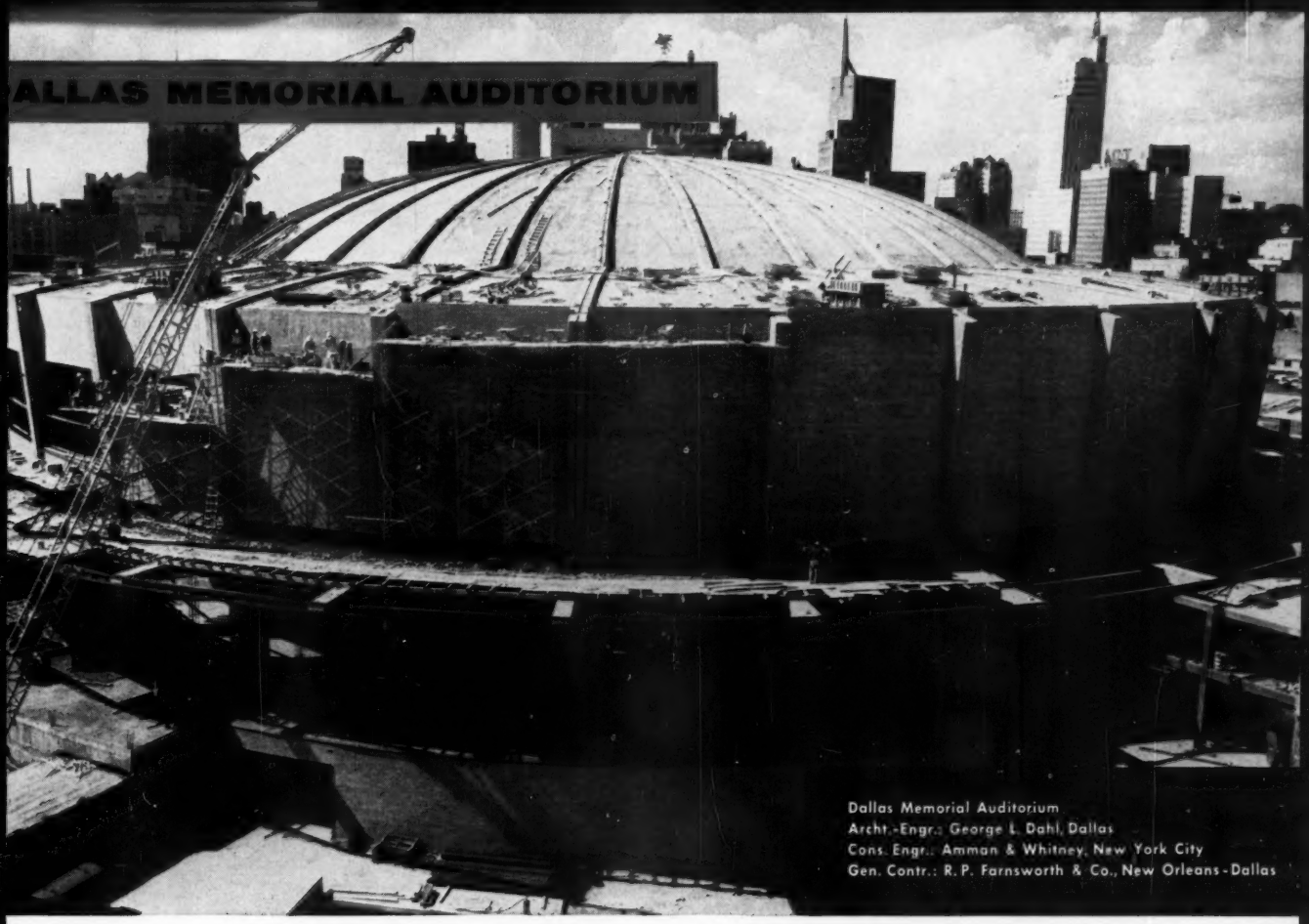

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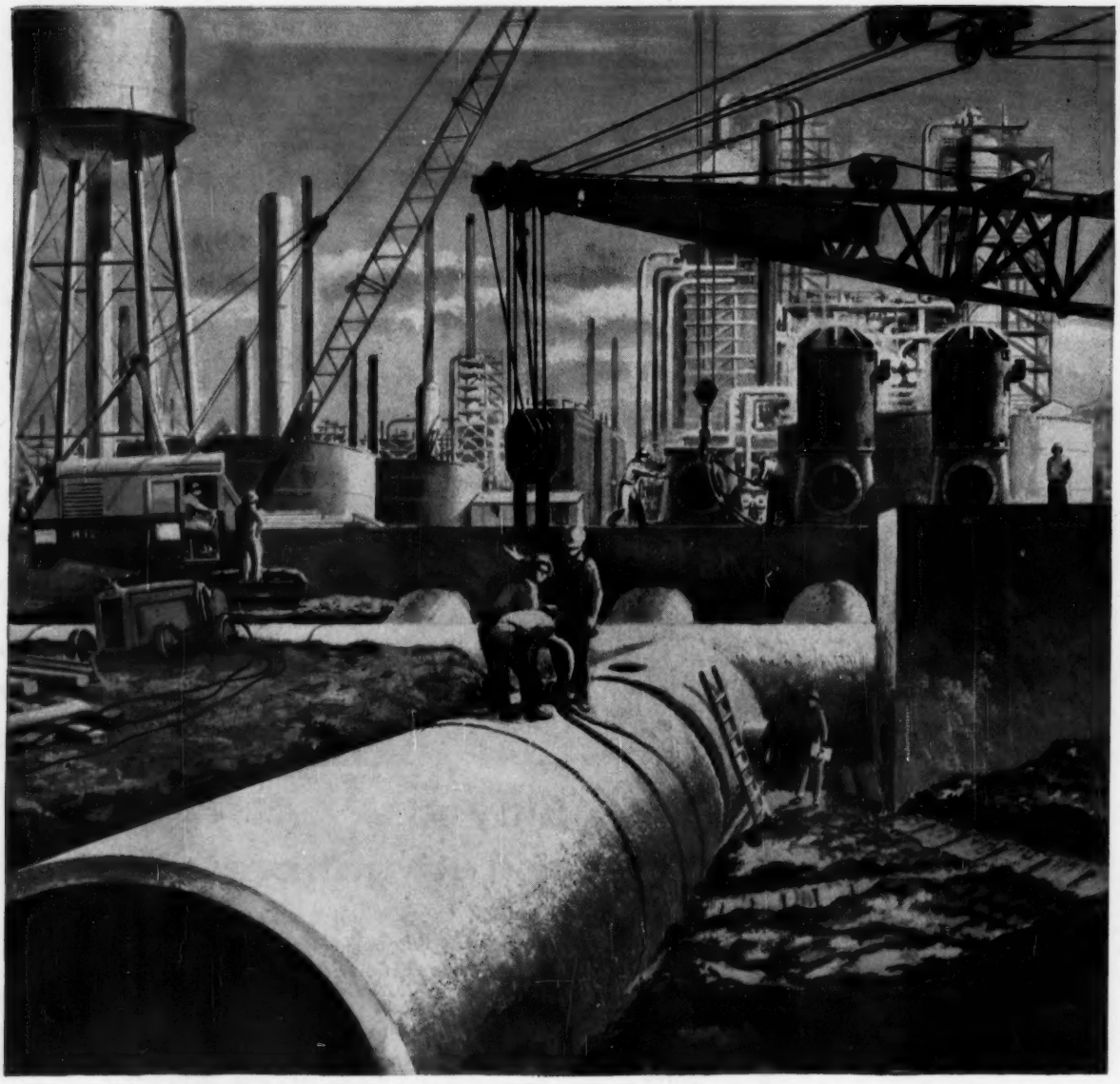

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